Rhodora

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CONTRIBUTIONS FROM THE GRAY HERBARIUM OF HARVARD UNIVERSITY.— NEW SERIES, No. XL.

A BOTANICAL EXPEDITION TO NEWFOUNDLAND AND SOUTHERN LABRADOR.[1]

M. L. FERNALD.

(Plates 86–91).

PART I. JOURNAL OF THE EXPEDITION.

IN recent years few lands have figured more prominently in our American papers and in our treaty negotiations than Newfoundland, the oldest of Great Britain's colonial possessions, the largest island in the western hemisphere and, with the exception of Great Britain herself, the largest island in Atlantic waters. Nevertheless, although many other British colonies have had their vascular floras adequately worked out in such classic publications as Bentham's *Flora Australiensis* (7 vols.), Hooker's *Flora of British India* (7 vols.), Hooker's *Flora Tasmaniae,* and Grisebach's *Flora of the British West Indies;* and the French islands of St. Pierre and Miquelon, immediately south of Newfoundland, have their *Florule des îles Saint Pierre et Miquelon* by Bonnet and the *Flora Miquelonensis* by Delamare, Renauld & Cardot; Newfoundland has been left to shift for herself.

It is true that several collections have been made upon the island — by Sir Joseph Banks [2] and by John Fraser in the second half of the 18th century; by Bachelot de la Pylaie, Cormack, Miss Brenton and

[1] Read at the meeting of the New England Botanical Club, March 3, 1911.

[2] See James Britten, Journ. Bot. xlii. 84 (1904).

others early in the 19th century; by Dr. John Bell, Dr. Robert Bell, Henry Reeks, Professor Roland Thaxter, J. D. Sornborger, and numerous others[1]; but upon some of these collections no publications have been based, while others have been the bases for comparatively brief lists. La Pylaie undertook the preparation of an elaborate *Flore de Terre-Neuve et des Iles Saint-Pierre et Miclon* with one illustrations drawn from living plants, but only ~~our~~ section, devoted to *Algae*, was issued.[2] In 1825, however, he published a little book, *Voyage à l'ile de Terre-Neuve,* giving a journal of his explorations and many notes on the vascular plants and their distribution, publishing several new but undefined names, and recording numerous species of more than usual interest: *Schizaea pusilla* (*S. filifolia* La Pylaie) "dans certaines parties de ces bas-fonds. . . .qu'on nomme *Swamps* dans l'Amérique septentrionale"; *Salix reticulata* on the barrens by Ingornachoix Bay; "*l'Alchemilla officinalis,* dans le partie inférieure des coteaux" of Quirpon Island; and many others which may be discussed at another time. William E. Cormack published an account of his journey made in 1822 across the island from Trinity Bay to Bay St. George and made notes upon some of the plants seen. His account, reprinted in 1873,[3] is rare even in its reprinted form and the plants enumerated, often under unintelligible names, are chiefly the commoner species. Reeks published a somewhat pretentious list of the vascular plants[4] based upon his observations on the west coast, and proposed three new species which were overlooked by the editors of *Index Kewensis* — a *Viola* of the *blanda* group, a *Euphrasia* which was collected in quantity last summer at the type locality and which is uncomfortably near our New England *E. Randii,* and an *Iris* which is clearly *I. setosa,* var. *canadensis.* Reeks's collections, so far as known, were not preserved and his list contains many entries extremely doubtful until the past summer and others which are obvious errors of determination. Dr. John Bell published a very readable account[5] of his trip made in June and July, 1867, and noted some of the commonest plants, with a few which are certainly rare or

[1] For further notes see Robinson & Schrenk, Can. Rec. Sci. vii. 4, 5 (1896).

[2] Paris, 1829.

[3] W. E. Cormack: Narrative of a Journey across the Island of Newfoundland. Reprinted by Moses Harvey (St. John's, 1873).

[4] Henry Reeks: A List of the Flowering Plants & Ferns of Newfoundland with Metereological Observations (Newbury, England, 1873).

[5] John Bell: The Plants of the West Coast of Newfoundland. Can. Nat. ser. 2, iv. 256–263 (1869); v. 54–61 (1870).

local on the island — *Claytonia caroliniana* from a mountain side south of the Great Cod Roy River; *Dryopteris fragrans* from Cairn Mountain; *Epilobium latifolium* from Flat Bay Brook and Grand Lake — and several which were surely misidentified.[1] Dr. Robert Bell's collections made in southeastern Newfoundland in 1885 were the basis of a list (102 vascular plants) by Professor John Macoun.[2]

The largest collections made upon the island by a resident were those of the late Rev. Arthur C. Waghorne who in his missionary work travelled widely and is now remembered at many of the fishing ports of both Newfoundland and Labrador, where he often dried his pressing papers by the kitchen fires. Mr. Waghorne collected rather extensively and his specimens (poorly prepared and labeled in a crabbed and often illegible hand and determined with varying degrees of accuracy) are found in several of our larger herbaria, but the major part of his collections are now deposited with the Geological Survey of Newfoundland. Toward the end of his life Mr. Waghorne had issued three parts (*Polypetalae* and *Gamopetalae*) of his *Flora of Newfoundland, Labrador and St. Pierre et Miquelon.*[3]

Of a more satisfactory character both as to specimens and determinations are the large collections of the past two decades made by three parties of American botanists. In 1894 Drs. Benjamin L. Robinson and Hermann von Schrenk spent the summer collecting in the Avalon Peninsula, with a short side trip to the lower Exploits River. Upon their extensive collections they based a 29 page report published in 1896.[4] In 1901 the New York Botanical Garden sent an expedition to Newfoundland. The members of the party, Messrs. C. D. Howe and W. F. Lang, were algologists but they supplemented their collections of Algae by a large series of vascular plants. So far as I am

[1] Dr. Bell's *Vallisneria spiralis* which the waves "rolled in quantities" on the beach of Bay St. George was certainly *Zostera marina*, his *Viburnum Lentago* must have been the common *V. cassinoides* which he does not mention, his *Cirsium pumilum* from "The Gravels" was undoubtedly a form of *C. muticum* (probably var. *monticola* which is common in western Newfoundland), his *Aspidium marginale* from Bay of Islands was unquestionably the there common *A. Filix-mas*; and there is grave doubt of the occurrence in Newfoundland of such plants, mentioned by him, as *Asplenium thelypteroides*, *Salix petiolaris*, *Betula lenta*, *Thalictrum dioicum*, *Lonicera oblongifolia*, and *Viburnum acerifolium*.

[2] John Macoun: List of Plants collected in Newfoundland in 1885 by Dr. Robert Bell. Geol. Surv. Can., Ann. Rep. n. s., i. 21–25 D D (1886).

[3] Waghorne, Trans. Nova Scotia Inst. Sci., ser. 2. i. 359–375 (1893), ii. 17–34 (1895), ii. 361–401 (1898).

[4] Robinson and von Schrenk: Notes upon the Flora of Newfoundland, Can. Rec. Sci. vii. 3–31 (1896).

informed, no special publication has ever been made upon their collection of flowering plants and ferns. In July and August, 1908, two members of the New England Botanical Club, Drs. Edwin H. Eames and Charles C. Godfrey, spent nearly a month in southwestern Newfoundland, between Port aux Basques and the Bay of Islands, bringing back about 400 species, 50 of them previously unknown from the island. Their results were published in Rhodora [1] for May, 1909.

This, so far as I am aware, summarizes briefly the more important botanical work in Newfoundland up to the past summer. The reasons for this rather meagre record are numerous and, when we look into the history of the colony and realize that until very recently the people of the island have all depended upon the sea, readily understood. But I imagine that with most of us who spend our summers on shore one of the most important reasons for neglecting Newfoundland has been a failure to appreciate how readily accessible is this island of *Terra Nova* which has so long remained to botanists a *Terra Incognita* as well. Few of us realize that Newfoundland is about 350 miles across from east to west and approximately the same from north to south (farther than from Boston to Quebec or about as far as from Boston to Baltimore) and contains 42,200 square miles; i. e. is larger than the island of Cuba or two thirds as large as New England. When this immense area is taken into account it will be readily admitted that, in spite of the notes already published, the flora of Newfoundland as a whole has been among the least known of any flora in civilized America.

And so, in the hope of learning something more of the region and of comparing the flora with that of the mainland and Anticosti Island on the western side of the Gulf of St. Lawrence, the expedition of 1910 was organized. I was fortunate in having as companions Professor Karl M. Wiegand, who had accompanied me on a previous summer's campaign, Mr. Joseph Kittredge, Jr., one of my students, who went as general assistant but soon proved so efficient that he was doing original exploring, and Mr. Alfred V. Kidder, an archaeologist and ethnologist, who represented the Peabody Museum of Harvard University.

Our first sight of Newfoundland was the conventional one, but none the less thrilling and picturesque. Upon rising early on the morning

[1] E. H. Eames: Notes upon the Flora of Newfoundland, Rhodora, xi. 85–99 (1909).

of July 3d as the "Bruce" (now lying at the bottom of Cabot Strait) approached Port aux Basques we gazed with delight upon the great granitic tablelands, their summits and slopes so covered with snow and ice that it was difficult to realize that less than two days before we had left New England sweltering in untempered heat and dust. So here, at our first landing on the island, we almost regretted that we had ticketed through to the Bay of Islands (140 miles north of Port aux Basques), for surely no country could be more tempting to a botanist from farther south nor hold out more hope of boreal plants than this first spot to meet our expectant gaze. But the train would not wait for us to climb the mountains so, making mental note that we must return to explore the region of Port aux Basques and the Cape Ray Mountains, we entered the dining car and had breakfast while the train was surging along winding valleys and around hills or making its way across the less treacherous parts of extensive moors and bogs. By the time breakfast was over and we settled down to uninterrupted observation of the landscape we had passed under more snow-covered tablelands and were following the western flank of the Long Range through the Carboniferous sandstones north of Cape Ray. The region was in places heavily forested, but with occasional extensive bogs which increased in abundance and area as we approached the coast. From the train they seemed exactly like our New England sphagnum bogs, except that there *Arethusa* grew in close colonies forming brilliant spots, as if pots of fifty or more finely flowered plants were set here and there upon the barren; the wet places were often densely carpeted with the little dwarf birch, *Betula nana* L., var. *Michauxii* (Spach) Regel;[1] and there were great carpets bright copper-colored with a cotton-grass which I recognized as my own *Eriophorum callitrix,* var. *erubescens,* a beautiful plant which was thus far known only from Newfoundland and which I had seen only in the herbarium. Such bogs, covered with the *Eriophorum* and the *Betula,* soon began the tantalizing habit, as it seemed to us, of appearing whenever the train whistled for a station but just as regularly disappearing before the station was actually reached. We kept up a continuous "hide and seek" with the *Eriophorum* and the *Betula* for some hours but were unable to catch them near a railway station,

[1] In this paper the authors of species and varieties are given only for such plants as are not included in Gray's Manual, ed. 7.

so we finally solaced ourselves with the thought that they were so abundant that we should find them about the Bay of Islands. But, after we had followed this type of country for seventy-five miles so that we were beginning to think of it as typical Newfoundland, there was a sudden change. The broad open bogs or barrens with scattered Black Spruce and Larch and with the *Eriophorum* and *Betula*, *Arethusa*, *Sarracenia*, *Rubus Chamaemorus*, and *Andromeda*, abruptly gave way to a beautiful dense forest of White Spruce with open park-like glades and springy meadows, with now and then a white mass which we recognized as *Salix candida*, or a clump of pink and white Showy Ladies' Slipper (*Cypripedium hirsutum*). Upon comparing the time-table and Howley's geological map, which quickly became our "guide, philospher and friend" for the summer, it was obvious — just as if the abrupt change in vegetation were not in itself sufficient evidence — that we had left the Carboniferous sandstone area and had entered the Silurian limestones which extend from here to the Bay of Islands and far beyond. Soon after passing St. George's Pond we caught fleeting and thrilling glimpses over the forested valleys of treeless reddish-brown slopes in the West, just like Mt. Albert as one sees it from the East, and we knew, as already indicated by Murray's geological reports and Howley's map, that we should soon be exploring serpentine mountains like those of Gaspé.

After leaving the head of Bay St. George we had seen no towns — only camps and occasional log-cabins — but suddenly emerging from among the Silurian hills we came unannounced upon the Bay of Islands with its prosperous and picturesque town, Birchy Cove. Our headquarters were to be at Petrie's which proved to be a comfortable house on a point reached ordinarily by walking a mile back on the track, but on such occasions as this — a first arrival — by motor boat. Here we found a comfortable home for the summer, with a kind host and hostess and interesting and friendly people at table, and we soon had a work-room equipped and in active use. We had entrusted, a week before we ourselves started, our drying paper, collecting boxes, waterproof clothes, tramping shoes and such other articles as we most needed to the mercies of our old acquaintance, the American Express Company, and this time some brilliant wag had shipped them from Cambridge to Newfoundland by way of Montreal! So during a four days' wait we attempted to explore in our travelling shoes, a programme which on the first day wrought havoc with them, for in

western Newfoundland, and apparently elsewhere on the island, as soon as one leaves the beaten path he is either in a saturated bog or on hard and ragged ridges. Our first few days were consequently occupied in gaining a general knowledge of the region and in picking out spots for more thorough exploration. Immediately around Birchy Cove the woods have been terribly destroyed by forest fire, exposing baked ledges over thousands of acres, and of course in such soilless spots the botanizing was practically spoiled. Similarly, along the roadsides the sheep had browsed so closely that there was little hope there, but we soon discovered unspoiled slopes and mossy woodland glades which exhibited a flora suggesting that of Aroostook County, Maine, or Bonaventure and Gaspé Counties, Quebec, with the abundance of *Selaginella selaginoides, Habenaria dilatata* and *hyperborea, Cypripedium hirsutum, Carex gynocrates, vaginata,* and *castanea, Tofieldia glutinosa, Geum macrophyllum, Osmorhiza obtusa, Pinguicula vulgaris,* and *Galium labradoricum*; but for some reason, after all, these rich mossy woods of the Silurian hills were quite unlike those of the Silurian region of northern Maine and adjacent Canada, and after many excursions we found out why. There is no Arbor Vitae (*Thuja occidentalis*) in Newfoundland and consequently there are no Arbor Vitae swamps such as we find so generally in our northern calcareous regions; and as the summer passed we were more and more impressed with this singular desideratum, for the absence of Arbor Vitae seems to deprive the island of many of the plants we find so abundantly in its shade: in Newfoundland we watched in vain for *Equisetum pratense, Orchis rotundifolia, Calypso bulbosa, Corallorhiza striata, Pyrola asarifolia, Lonicera involucrata, Valeriana uliginosa,* and *Senecio discoideus,* which on the Gaspé Peninsula are so generally found in the humus of the Arbor Vitae swamps.

But we were not looking simply for familiar plants; and, although the absence of many which we confidently expected was a surprise and opened our eyes and minds to a problem not previously considered, there were plenty of good things to be collected. Many springy places and brook-beds were filled with a dense tangle of a sprawling plant with white clammy pubescence and brilliant yellow flowers, *Mimulus moschatus,* much commoner in the Rocky Mountain region than in the East. The thickets and open woods had tall clumps of a *Scrophularia* strange to us of New England — true *S. nodosa* L., apparently identical with the plant of Europe. In the woods also

were great clumps of *Dryopteris Filix-mas* and *Polystichum Braunii*, with here and there *P. Lonchitis* on the shaded limestone shingle. *Vaccinium ovalifolium*, abundant from Alaska to California and also on the Shickshock Mts. of Gaspé, was common on the hill-tops, as was *Galium kamtschaticum* in cold ravines; and typical *Valeriana sylvatica* Banks (smaller in all parts than our *V. uliginosa*) was occasionally found. Singularly enough each bog and wet woodland glade seemed to have its own specialty: in one *Bartonia iodandra*, a species known only in Newfoundland and Cape Breton; in another *Utricularia clandestina*, heretofore unknown east of New Brunswick; in another a perplexing *Euphrasia*, *Rhinanthus*, or *Senecio*. Along the railway were strange weeds, the most interesting of them perhaps being the Fairy Flax, *Linum catharticum*, with white flowers and opposite leaves, both unusual characters in the genus, and the handsome thistle, *Cirsium palustre*, which was afterward seen at points more than fifty miles apart.

Upon the arrival of our driers, presses and old clothes, it was decided that Kidder and I should undertake a trip across the Island by way of the East Branch of the Humber River and Indian Brook to Notre Dame Bay. We went by train to a point east of Howley whence we could easily reach the Humber system at the Goose Ponds. This region was in the midst of a Carboniferous sandstone area, and I was delighted to find myself actually camping on a sandy and boggy barren such as we had so long watched from the train between Cape Ray and the head of Bay St. George. Here was the flora we had seen from the train, but quite unlike that of the calcareous Silurian region about the head of the Bay of Islands. Except for the nearly endemic *Eriophorum callitrix*, var. *erubescens* Fernald and *Betula nana* L., var. *Michauxii* (Spach) Regel and the everywhere abundant *Calamagrostis Pickeringii*, we might have been on the barren coast of eastern New England, and the chief botanical excitement came from adding to the list of Newfoundland plants such treasures as *Dryopteris cristata*, *Lycopodium clavatum*, var. *megastachyon* Fernald & Bissell,[1] *L. complanatum*, *Scheuchzeria palustris*, *Panicum implicatum*, *Carex trisperma*, var. *Billingsii*, *C. polygama* and *limosa*, *Listera auriculata*, *Salix lucida*, var. *intonsa* and *S. pedicellaris*, var. *hypoglauca* Fernald [2]; while I tried to rouse enthusiasm over *Pinus resinosa*,

[1] Rhodora, xii. 53 (1910). [2] Rhodora, xi. 161 (1909).

Carex debilis, var. *Rudgei*, *C. intumescens*, *Eriocaulon septangulare*, *Salix humilis*, *Populus tremuloides*, *Pyrus arbutifolia*, var. *atropurpurea*, *Ilex verticillata*, *Vaccinium macrocarpon*, *Melampyrum lineare* and *Diervilla Lonicera*. This long list is given, obviously not to display any botanical richness of the region, but because in our whole summer's experience most of these common plants of sterile coastal New England were nowhere encountered except in the sandstone areas of central Newfoundland and of Bay St. George or occasionally on the most sterile summits of hills and mountains. About Sandy Lake are dunes and sandy beaches covered with *Elymus arenarius* and *Juniperus horizontalis*, quite like a silicious coastal strip of eastern New England, but here in the very heart of Newfoundland.

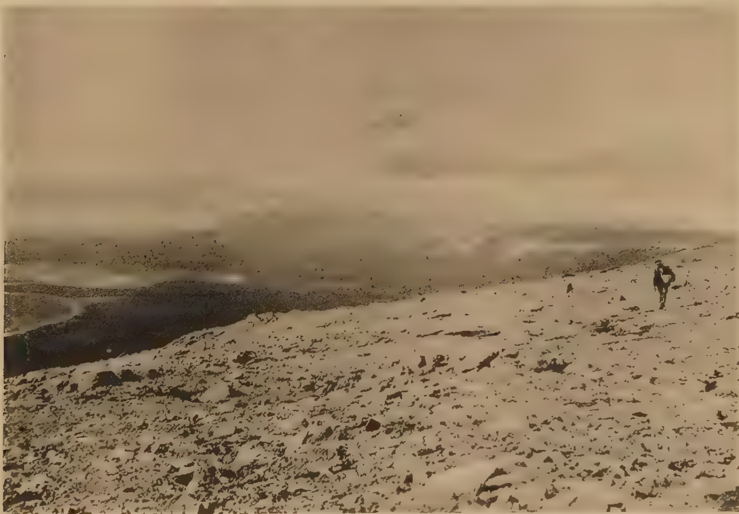
We climbed one of the higher granite mountains of the interior, Mt. Steepmore (or Seemore) but it had little to add to what was on the lower barrens, except *Festuca ovina*, var. *brevifolia*, *Carex scirpoidea* and *deflexa*, *Juncus trifidus*, *Empetrum nigrum*, var. *purpureum* (with small coral-red berries), *Loiseleuria procumbens*, *Arctostaphylos alpina* and *Diapensia lapponica*. In one of the Birchy Ponds at its base was the most beautiful pondweed imaginable, *Potamogeton praelongus*, forma *elegans* Tiselius, a form described from Scandinavia, with delicate translucent leaves almost a foot (3 dm.) long.

A combination of mishaps, head winds, and ineffective guide forced us to turn back before reaching the eastern coast and, after waiting half the night in a peat-bog for the freight train due at 3 o'clock in the afternoon and which we stopped by waving a fire-brand, we reached headquarters in time to see Wiegand and Kittredge starting in the early morning for a three days' trip to the Marble Mountain region of the Humber River. They returned in due time heavily laden with a good collection of calciphiles, among them *Polystichum Lonchitis*, *Carex eburnea*, *Tofieldia palustris*, *Microstylis monophyllos*, *Salix vestita* Pursh, *Arenaria verna*, var. *propinqua*, *A. litorea*, a species probably long ago found in Newfoundland and reported by Pursh as *A. juniperina* (see RHODORA, viii. 34), *Thalictrum alpinum* L., *Anemone parviflora*, *Draba arabisans*, *Saxifraga Aizoon*, *aizoides*, and *oppositifolia*, an *Alchemilla*, *Erigeron hyssopifolius*, and *Taraxacum ceratophorum* (Ledeb.) DC., mostly species which had been recorded by la Pylaie and which we afterward found to be common enough on all the exposed limestones of the West Coast, but certainly a refreshing contrast to the commonplace collection which had come back from the sandy barrens and bogs of Goose Pond and Sandy Lake.

The next move was a double one, Wiegand and Kidder taking the "Home" north to Cow Head in the Silurian limestones north of St. Paul's Bay, Kittredge and I making a first attack upon the serpentine barren which, five miles west of Birchy Cove, forms the northeastern flank of the Blomidon (with some propriety corrupted to "Blow-me-down") Range. We went with keen anticipations, for this serpentine barren from the distance looked so like a reduced Mt. Albert that we felt it inevitable that it should yield the plants which in Gaspé distinguish the serpentine from all the other mountains. And we were in no way disappointed. Here was Mt. Albert all over again; and during the whole summer we did not have a closer day's work than on that single day in late July when, starting soon after sunrise, we tramped in to the mountain from Benoit's Cove in a heavy thunder storm which rendered more obscure an overgrown trail, climbed up to the tableland (plate 87, fig. 3) botanizing all the way, came down over a snow-field at the risk of our lives as it proved, thus teaching us a valuable lesson in mountaineering, and returned before dark five miles through the woods to Benoit's Cove. Our boxes and rück-sacks were crowded full and Mt. Albert,[1] the great serpentine tableland of Gaspé, will be suggested in the plants we had found: *Adiantum pedatum* L., var. *aleuticum* Rupr., first recognized in eastern America on Mt. Albert, occurring in the Selkirks, according to Professor F. K. Butters, only on a serpentine ridge, and similarly, according to Professor John Macoun, found on Vancouver Island only on the serpentine or other magnesian rocks; *Danthonia intermedia* Vasey, unknown elsewhere in the East except on Mt. Albert; *Festuca scabrella* Torr., recently confused with *F. altaica* Trin. and heretofore known in eastern America only on Mt. Albert where it abounds; *Lychnis alpina* L., otherwise unknown south of Labrador except on Mt. Albert and along Coal or Serpentine River in Newfoundland, which takes its name from the serpentine rocks of the Blomidon Range and the Lewis Hills; *Arenaria arctica* Stev. (ditto); *Arenaria ciliata* L., var. *humifusa* Hornem. (ditto), a plant identical with *A. norvegica* Gunn. which in the British Isles has but two stations, one in the Orkneys (soil not stated), the other on a serpentine hill on one of the Shetland Islands[2]; *Statice sibirica* (Turcz.) Ledeb. (Mt. Albert)

[1] See Rhodora, ix. 155, 158, etc. (1907).
[2] See Edmundston, Flora of Shetland, xv (1845); also Syme, English Bot. ii. 104 (1873), where it is stated (105) that *A. ciliata* (true) occurs on calcareous cliffs.

3. Northeastern Tablelands of the Blomidon Range, looking across the Gorge of Blomidon Brook from the treeless Serpentine to the wooded Diorite area.



4. Dry limestone Barren, western edge of Table Mountain, Port à Port Bay.

and *Solidago multiradiata* Ait., the common Arctic American representative of the *Virgaurea* group.

We were still putting our exciting collections into press when the "Home" returned from the North bringing Wiegand with his Cow Head material — practically all the calciphiles of the Humber River marbles and some not met before: *Botrychium Lunaria*, a species which abounds locally in calcareous gravels and beaches or on damp turfy slopes around much of the Gulf of St. Lawrence, often attaining splendid proportions (2-2.5 dm. high, with the sterile lamina 6–7 cm. long); *Poa alpina* and *P. eminens*, two of the handsomest of the genus; *Salix Pseudo-myrsinites* Anderss., a frequent species in the Canadian Rockies and on the Gaspé limestones; one of the puzzling Scurvy Grasses (*Cochlearia anglica* L.); *Draba incana* L. and its var. *confusa* (Ehrh.) Poir. which are familiar to those who have been at Percé in eastern Quebec; *Arabis alpina* L.; *Saxifraga caespitosa* L.; *Parnassia parviflora; Oxytropis campestris* DC., var. *caerulea* Koch, a singularly misnamed plant since its flowers are crimson or "rose-purple" and, like those of many other *Leguminosae*, become blue only when dry; and *Hedysarum alpinum* L., a larger-flowered plant than our variety [1] of Gaspé, the St. John River, and Willoughby, which, as maintained more than a century ago by Michaux and more recently by Fedtschenko [2] and by Ostenfeld,[3] certainly cannot be separated specifically from the Siberian *H. alpinum*. But the plant which upon first discovery was most interesting was a beautiful blue gentian, new to us as well as to the Gray Herbarium, *Gentiana nesophila* Holm, a species heretofore supposed to grow only on Anticosti, but after our first introduction found to be a common plant on the limestones of western Newfoundland as far north and south as we explored — Pointe Riche at the north, Port à Port at the south. In fact this gentian, which abounds on the limy gravels and in damp spots about Ingornachoix Bay and the foot of Bay St. John, was undoubtedly seen by la Pylaie who in that region found "une gentiane voisine du *pneumonanthe*."

Now came the longest flight, the whole party like the Newfoundland fishermen migrating to the Labrador — not very far into Labrador, but north of the Straits of Belle Isle and east of the Canadian bound-

[1] *Hedysarum alpinum*: *americanum* Michx. Fl. ii. 74 (1803). *H. boreale* Nutt. Gen. ii. 110 (1818). *H. americanum* Britton, Mem. Torr. Bot. Cl. v. 201 (1894).

[2] Fedtschenko: Generis Hedysari revisio. Act. Hort. Petrop. xix. 253–258 (1901).

[3] Ostenfeld: Vascular Plants collected in Arctic North America by the Gjöa Expedition. Vidensk. Selsk. Skrift. I Klasse, No. viii. 55, 56 (1909).

ary. In earlier days the name Labrador was used in a general way for the entire peninsula north of the lower St. Lawrence and the Gulf, but in 1876 the jurisdiction of the Government of Newfoundland was defined as that portion of the Labrador Peninsula lying east of a line drawn directly north from Blanc Sablon to 52° N. latitude, thence along the height of land to a point on the mainland-shore nearly south of Port Burwell, Cape Chudleigh. West of this boundary the region is Canadian, the southern tract being Saguenay County, Quebec, the northern Ungava. Many of the older collections made on the Labrador Peninsula prior to this delimitation, and a few more recent ones, from west of Blanc Sablon River are designated as coming from "Labrador" and upon such specimens many so-called Labrador records have been made and new species based — for example, *Calamagrostris labradorica* Kearney, the type from Bonne Espérance, Saguenay County, Quebec, and *Galium labradoricum*, deriving its name from an old specimen presumably from the North Shore of the River or Gulf of St. Lawrence. If we wish our geographic citations to be as generally intelligible as possible it seems wisest to refer to the regions in the Canadian portion of the Peninsula by the most definite designations available (Saguenay County, etc.) and to reserve the name Labrador in its restricted sense (as opposed to the more general Labrador Peninsula), as is done in most if not all up-to-date atlases, for the outer coastal strip of the Peninsula.[1] In these

[1] I have been criticized by at least one student of Natural History for accepting the political boundary and restricting the use of the term Labrador to the Newfoundland dependency, labeling specimens from west of the Blanc Sablon River as from Saguenay County, Quebec. In so doing, however, I simply aim at clearness of record. No one whose daily work brings him the constant annoyance of trying to settle beyond doubt whether many old specimens, often the type-specimens themselves, labeled "Oregon," "Missouri," or "Northwest Territory," really come from Washington, Oregon, Idaho, or western Montana; eastern Montana, Wyoming, Colorado, or some region between the Rocky Mountain states and the Mississippi River; or, in case of Northwest Territory, from one of the Canadian provinces of Manitoba, Assiniboia, Saskatchewan, etc., or even one of our Great Lake states — no one whose daily work is interrupted by the necessity of tracing out the sources of old and obscurely labeled specimens can fail to grasp at every restricted use of a geographic name which makes for simplicity and clearness in citation. In fact, for those who wish to cite exact localities it would be a great advantage if the Labrador Peninsula were subdivided into many more clearly defined districts, for the divisions, Newfoundland Labrador, Ungava, and Saguenay County, Quebec, are all too large for the ready localization of a given point. Thus if we have a plant or other specimen from "Esquimaux Island, Labrador" we are entirely in doubt, unless there is a record of the collector's travels (which most busy people should not be required to look up) whether the specimen came from one of the Mingan Islands (north of Anticosti) in Saguenay County, Quebec, from the famous island at the mouth of Esquimaux River, near the Straits of Belle Isle (also in Saguenay County), from the island in Hamilton Inlet, or from one of the other islands along the coast of the Atlantic, Ungava Bay, or Hudson Bay which were formerly the rendezvous of this now almost extinct race.

notes the official boundary is recognized as it is in the most pretentious publication yet available upon the flora, Delabarre's Report on Botany in his *Report of the Brown-Harvard Expedition to Nachvak, Labrador.*[1]

In the latter work, which in 1902 enumerated all the plants seen on the coast of "Labrador proper" during the summer of 1900 by Professor Delabarre, nearly 200 vascular plants were listed. The work which may yet be accomplished by trained and discriminating explorers is shown by the fact that in Wiegand and Kittredge's one day at Forteau and my five botanizing days at Blanc Sablon, where I once more had the genial companionship of Kidder (principally absorbed in gathering Esquimaux arrow-heads), 331 species of flowering plants and ferns were collected, and of these more than 200 are not in Delabarre's list.

As just intimated, Wiegand and Kittredge went to Forteau, Kidder and I to Blanc Sablon. This division of the party was made in order to compare these two regions having similar geological and geographical conditions, which will become clear by a brief description of Blanc Sablon and the neighboring coast. West of the Straits of Belle Isle the entire north shore of the Gulf and the lower River St. Lawrence is composed of Laurentian gneiss and allied rocks, except at the Mingan region, which is limestone. But the words of Sir William Logan describe the general conditions with authority: "Between this exposure [the Mingan Islands] and Bradore Bay, the distance is about 300 miles. The shore, which is very much indented by bays and inlets, and fringed with a multitude of islands, presents an almost continuous line of bare rock; but in no part of it have there been observed any strata, but such as belong to the Laurentian series. On the east side of Bradore Bay, which is situated near to the entrance to the Straits of Belle Isle from the Gulf of St. Lawrence, the palaeozoic rocks again present themselves. Resting on the Laurentian gneiss, they run along the north coast for nearly eighty miles, with a breadth of probably ten or twelve miles."[2] At Blanc Sablon (plate 86, fig. 1) the flat country through which the river runs is a floor of Laurentian gneiss, in many places converted to shifting sand. Each side of the river the Cambrian limestones and calcareous sandstones rise as five terraces until at an altitude of about 350 feet (115 m.) they reach the tableland which stretches west or east and north

[1] Delabarre, Bull. Geogr. Soc. Phila. iii. 167–201 (1902).
[2] Logan, Canadian Geology, 287 (1863).

until cut through by other streams. Here was an ideal place to study the vegetation of a highly calcareous region side by side with the plants of a silicious and gneissoid area, and if anyone doubts the dissimilarities of these floras he can find no better spot in which to undeceive himself than at Blanc Sablon. And if he is received with the hospitality and desire to make his stop successful which were extended to us by our wide-awake host, Mr. Edwin G. Grant, manager of the cod-fishing "room," and his son and daughter in their large and comfortable summer residence — more than a hundred years old, but with electric push-buttons, typewriter and other signs of contact with the world not looked for on the Labrador as ordinarily described; or if he is entertained as we were by Mr. Grant's friendly rival and neighbor, Mr. Thomas Morel, manager of the fishery on the Canadian side, and his good wife, with pictures and accounts of their home in Jersey, with music and discussions of European galleries and theatres, and with lettuce salad dressed with real Jersey cream and a sight of their garden with a patch of carefully sheltered cucumbers coming on; he will feel that the open-handed hospitality which we read of in early accounts of the Hudson Bay Company is equally dispensed by the Labrador fisherman.

The botanizing at Blanc Sablon furnished such an embarrassment of riches that it is now possible to mention only a few characteristic plants. As representative a day as any was Saturday, August 6, the last field-day I had there. Starting from the settlement on the Labrador side, where the shore is bordered by a broad strand-terrace of gneissoid gravel and sand covered by a broad belt of Strand Wheat (*Elymus arenarius*), with *Catabrosa aquatica, Montia lamprosperma* Cham.,[1] *Stellaria crassifolia,* and *Ranunculus hyperboreus* Rottb., a little creeping buttercup with only 3 lemon-yellow petals, in the damp hollows, I made my way through the group of Esquimaux dogs, which all summer hang about the fishery, across the sandy and rocky plain which extends from the river to the terrace-slope. As I remember writing home, the *commonest flower* of these Laurentian plains is *Carex rariflora,* though with singular regard for its specific name it is by all means the rarest of its genus in New England. In some places on the drier part of the plain the turf was composed of *Carex stylosa* C. A. Meyer, an Alaskan species which, like many other Alaskan plants, reappears along the Straits of Belle Isle. In the

[1] See Fernald & Wiegand, Rhodora, xii. 138 (1910).

sand-blows were *Luzula spicata* and a viviparous form of *Festuca ovina* L., var. *supina* (Schur.) Hack., subvar. *pubiflora* Hack., and here were the common plants of the granitic barrens of Newfoundland, Gaspé, or northern New England: the Whortleberry (*Vaccinium uliginosum*) the Bearberry (*Arctostaphylos alpina*), the Curlew-berry (*Empetrum nigrum*) both the typical black-fruited plant and the var. *purpureum* with bright coral-red berries, Baked Apple (*Rubus Chamaemorus*), Dewberry or Plumboy (*Rubus arcticus*), Partridge-berry or Red Berry (*Vaccinium Vitis-Idaea*, var. *minus*) and *Loiseleuria, Diapensia, Betula glandulosa, Salix Uva-ursi*, etc. The bogs were everywhere brilliant with Cotton Grasses, *Eriophorum angustifolium, gracile, tenellum* and *callitrix*, but handsomest of all the splendid bronze-topped *E. Chamissonis*, and, its known range now extended across from Newfoundland, the recently described *E. callitrix*, var. *erubescens* Fernald. Coming now to the head of a cove the trail passed back of the Strand Wheat, with here and there a colony of the crimson *Rumex occidentalis* or of some perplexing *Epilobium*, clumps of the handsome sunflower-like *Senecio Pseudo-Arnica*, the splendid whitish-green grass, *Poa eminens*, and the bronze-purple *Calamagrostis lapponica* (Wahlenb.) Hartm., like *C. neglecta* with very long spikelets, and soon reached the foot of the limy terraces.

Immediately the veg~~a~~tation changed. The brooks tumbling and interlacing every few rods along the slopes from the summit-tableland were bordered by a luxuriant thicket of coarse herbs and low shrubs which, in early August, made as rich an alpestrine meadow as one could well imagine. Here was a tangle as high as one's head, with *Salix candida*, *S. vestita* Pursh, *S. Pseudo-myrsinites* Anderss., and several variations of *S. cordifolia* Pursh, strange Goldenrods and Asters, *Angelica atropurpurea*, *Heracleum lanatum*, and a strange villous *Urtica* composing the taller thicket. In making my way up the course of one of these brooks to the crest I encountered more than 175 species of vascular plants, surely a good number for one day's collecting on a Labrador meadow and one difficult to match in our more amiable climates. The brook-margins and moss-bordered rills were everywhere brilliant with Marsh Marigold (*Caltha palustris*) still in bloom, with white masses of *Arabis alpina* L., looking almost exactly like our garden species, the Old World *A. albida*, golden spires of the boreal Yellow Rocket (*Barbarea orthoceras* Ledeb.[1]) and blue

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[1] See Rhodora, xi. 140 (1909).

carpets of the northern Speedwell (*Veronica humifusa*), while a beautiful gray-green Ladies' Mantle (*Alchemilla* sp.) made a misty fringe at the edge of the tumbling waters. Occasionally in the wet moss there was a delicate carpet of *Cystopteris montana* (Lam.) Bernh., suggesting a compromise between a broad-fronded *C. bulbifera* and a stockily developed *Phegopteris Dryopteris*; or a colony of *Pinguicula vulgaris* with rich voilet flowers, ordinarily mingled with various Saxifrages and Drabas or the little white *Parnassia Kotzebuei* C. & S. (of southern Labrador, the Gaspé Peninsula, and the Alaskan area). On the exposed rocks at the crests of the terraces were great colonies of Cerastiums, differing from any we had got in Newfoundland and adding two more to the plants we had already collected which, by matching in the herbarium, we are forced for the time being to call vaguely "*Cerastium alpinum*." Occasionally in more open springy spots there were strange sedges and rushes: the chestnut-colored *Kobresia caricina* Willd., its range in eastern America now extended south from Greenland, or *Juncus triglumis* L., an extremely neat little species suggesting *J. stygius*. Near the top of the upper terrace was a meadow crimson and orange-scarlet with *Senecio pauciflorus* Pursh which has discoid heads, the involucre crimson-tinged, the corolla-lobes orange-red, and the anthers yellow.

I had hardly reached the crest at supper time and before turning back could have only the sad satisfaction of seeing for myself that beyond for miles stretched an alluring and to botanists unknown area of alpine meadows, bogs, pools and dry ridges which the approaching night and the call to supper, not to mention the serious difficulty of carrying more plants, forced me to leave until "next time." Returning to the plain, I descended the terrace by a new route, haunted by the consciousness that I was passing by innumerable good things, but stopping only once in the hasty descent to gather a conspicuous lilac-flowered *Erigeron*, the new *E. acris*, var. *oligocephalus*,[1] and again to look over some brackish rocks along shore. Here was a Scurvy Grass (*Cochlearia officinalis* L.) in splendid development, flowering and fruiting plants and new rosettes of thickish round leaves. I was curious to eat some of the plant which for centuries had been credited with great virtues and found it a most palatable salad, in texture crisp and somewhat fleshy, in flavor like horse-radish. Near by

[1] Fernald & Wiegand, Rhodora, xii. 226 (1910)

was an attractive and strange grass which proves to be *Hordeum boreale* Scribner & Smith, a species heretofore known only from Alaska to northern California. But it was growing late and I had so often been tardy at Mr. Grant's table that I hastened back this last day to leave if possible a better impression of my punctuality and appreciation and found a Labradorian meal which would please the most epicurean palate,— a choice of young puffins or young divers, with greens of *Atriplex patula*, var. *hastata*.

Although the boreal plants above enumerated and many others not here mentioned are the species which at first attract the New England botanist visiting the Straits of Belle Isle, they are after all surpassed in geographic interest by a large number of species which one might be tempted to ignore. Mingled with the northern species on the terrace-slopes are the following and many more which to the New Englander make a very tame list: *Phegopteris Dryopteris* and *polypodioides*, *Botrychium virginianum*, *Equisetum scirpoides*, *Milium effusum*, *Cinna latifolia*, *Carex Deweyana*, *vaginata*, *laxiflora*, var. *leptonervia*, and *capillaris*, var. *elongata*, *Clintonia borealis*, *Streptopus amplexifolius*, *Microstylis monophyllos*, *Ranunculus abortivus*, *Actaea rubra*, *Mitella nuda*, *Ribes triste*, *Geum macrophyllum*, *Viola Selkirkii*, *Viola renifolia*, *Conioselinum chinense*, *Chiogenes hispidula*, *Galium triflorum*, *Linnaea borealis*, var. *americana*, *Solidago macrophylla*, and *Petasites palmata*. If one were to enumerate the more typical woodland plants of northern New England and eastern Canada I am quite sure that all of these would be in the list. And it is for just this reason that their occurrence on the terraces and tablelands north of the Straits of Belle Isle is of greatest interest.

In such accounts as I have found (except possibly Cartier's) the coasts of the Straits of Belle Isle are described as desolate and bare, and even Cartier, in 1534, entering the Straits and anchoring at Blanc Sablon, was so impressed with the barrenness that he wrote: "If the land was as good as the harbors there are, it would be an advantage; but it should not be named the New Land [1] but [a land of] [2] stones and rocks frightful and ill shaped, for in all the said north coast I did not see a cart-load of earth, though I landed in many places. Except at Blanc Sablon [3] there is nothing but moss and small stunted woods;

[1] Cartier had just come up the east coast of Newfoundland and apparently took southern Labrador to be part of the same region.

[2] Bracketed phrase inserted by the translator.

[3] At Blanc Sablon the shores and flat country back of the shores are covered with drifting sand.

in short, I deem rather than otherwise, that it is the land that God gave to Cain;"[1] and again on his second voyage, in 1535, he wrote: "The whole of the said coast from the Castles as far as here[2] bears east-northeast and west-southwest, ranged with numerous islands and lands all hacked and stony, without any soil or woods, save in some valleys."[3] And at the present time the people at Blanc Sablon insist that there has never been any forest there and that no timber exists within four or five miles of the Straits. Yet, the first day I saw upon the terraces east of Blanc Sablon such plants as have just been enumerated I was convinced that a forest must have been there, since these are so distinctly woodland species and so decidedly not plants typical of the Arctic barrens and tundra. So my delight can be imagined when, crossing with Kidder the tableland east of Blanc Sablon, we came upon buried logs in the bog and soon after found numerous stumps protruding from the moss. Some of the stumps (plate 86, fig. 2), now much crumbled, were still a foot or more in diameter and indicated an ancient forest of considerable size. Just when this forest lived it is difficult to say, but if it still throve in the 16th century Cartier did not give a very clear indication of it. Only by such indefinite expressions as "except at Blanc Sablon there is nothing but moss and small stunted woods" and "without any soil or woods, save in some valleys" did he indicate a possible forest covering. But here at least was a remnant of the forest which had once sheltered *Carex Deweyana*, *Actaea rubra* and *Viola Selkirkii*, though at the present time only shrubs or dwarf straggling trees, as described by Cartier, thrive on the bleak and wind-swept shores of the Straits of Belle Isle; and that the forest was an extensive one and presumably once fringed the entire length of the Straits we are safe in assuming from the presence at Bonne Espérance, L'Anse au Clair, Forteau, Red Bay, and Chateau (as shown by the collections of John A. Allen and others) of a relict forest vegetation (sometimes further augmented by *Onoclea sensibilis, Osmorhiza obtusa, Pyrola secunda,* etc.) such as abounds on the terraces of Blanc Sablon.

The "Home" which we had expected back from Battle Harbor Saturday night came Sunday evening and we found ourselves sharing a stateroom with two professors from the Methodist College at

[1] J. P. Baxter, Memoir of Jacques Cartier, 86 (1906).
[2] From Chateau Bay as far as Brest, west of Blanc Sablon.
[3] J. P. Baxter, l. c. 130.

St. John's, who were making a circuit of Newfoundland collecting plants for their newly organized Natural History Society. As loyal British subjects they were trying to identify their plants by means of Bentham's *Handbook of the British Flora;* and I am sure they were able thus to identify nearly half the species they found, for of the known vascular plants of Newfoundland (scarcely 1000 species) more than 400 occur in Scotland, northern England or Ireland, though about 825 of them are found in the "manual region."

At Port Saunders we were joined again by Wiegand and Kittredge who, having met at Forteau with no such comfortable quarters as we enjoyed at Blanc Sablon, had come south a week before and had been having a busy week on the limestone barrens about Ingornachoix Bay and on Pointe Riche. They had some of the best things of Blanc Sablon — *Hordeum boreale* Scribner & Smith, *Kobresia caricina* Willd., *Juncus triglumis* L., etc. — and a most interesting lot besides: *Carex bicolor* All., quite like the smallest European specimens; *Salix reticulata* L., reported years ago from Ingornachoix Bay by la Pylaie and so far as we can make out just like the shrub of northern Europe; other strange willows including a beautifully distinct species allied to the Lapland *S. lanata* L.; *Lesquerella arctica* (Richardson) Watson, var. *Purshii* Watson, a single stunted individual but precious, for the plant had heretofore been known only from Anticosti; *Drosera anglica*, familiar in the marl-bogs of Gaspé; *Potentilla maculata* Pour., now extended south from northern Labrador; *P. nivea* L., an arctic species already familiar to me on calareous cliffs of eastern Quebec, but here with remarkable old thickened caudices; *Dryas integrifolia* Vahl, another arctic type familiar on the Gaspé limestones; *Campanula rotundifolia* L., var. *alaskana* Gray, a gigantic variety previously known only from the Bering Sea region; two new *Antennarias*, one of them a canescent variety of *A. alpina* (L.) R. Br. (var. *cana* Fernald & Wiegand [1]), the other apparently an undescribed species; *Tanacetum huronense* in a dense low and very pubescent form found in dry exposed shingle; and other good things too numerous to mention.

Once back to our presses at Birchy Cove it took us only two days to put up all our specimens and by means of corrugated boards and hot papers [2] to get them ready to leave, so that in three days we were

[1] Rhodora, xiii. 24 (1911). [2] See J. F. Collins, Rhodora, xii. 221 (1910).

established for a short time at the comfortable and to us quite luxurious "Log Cabin" at Stephenville Crossing at the head of Bay St. George. Kidder after the Labrador trip had returned to Boston for a happy errand — his marriage, and we naturally missed his hearty comradeship and the jingle in his rück-sack of arrow- and spear-heads as they clicked against the bones of ancient Esquimaux, Montagnais, or Beothuks.

The "Log Cabin" at Stephenville Crossing, more elegantly known as St. George's Hotel, is situated at the edge of extensive sand dunes where were *Ammophila arenaria, Carex silicea* and *C. hormathodes*, var. *invisa*, just as if we were on the coast of Cape Cod or Long Island. This region had been so thoroughly worked over by Messrs. Eames and Godfrey that there was little of novelty for us, but we were specially interested to find upon the sands or clays and the bogs just the plants which had been seen on the similar Carboniferous area of central Newfoundland, and a few others which were now beginning to mature: *Lycopodium inundatum, L. complanatum*, var. *flabelliforme, Spartina glabra*, var. *alterniflora, Scirpus subterminalis, Habenaria blephariglottis, Calopogon pulchellus, Hypericum virginicum, Cicuta bulbifera, Gaylussacia dumosa*, var. *Bigeloviana* Fernald,[1] and *G. baccata*, which are all typical species of our sterile New England coast. Around some of the sand-bottomed pools were dense carpets of *Juncus pelocarpus*, identical with the plant of our sandy shores, and, contrasting with it, the creeping or floating *J. subtilis*. All summer we had been forced by the abundance of the attractive but taxonomically most perplexing Eye Brights to collect many different lots of *Euphrasia*. But here were two or three which we had nowhere seen before, so that much of our time was taken in collecting and studying them.

Then on Monday, August 8, we drove out the north shore of Bay St. George to the village of Port à Port. Here the Carboniferous sandstones gave way to Silurian limestones and the locality which first attracted our attention and took practically all the time we had was the southwestern edge of Table Mountain (in Newfoundland almost every community on the west coast has its own "Table Mountain"), a white limestone tableland rising only about 1000 feet (300 meters) above Port à Port Bay. When we reached the crest we were

[1] Rhodora, xiii. 99 (1911).

puzzled to know where to begin, for we had only the one day for exploring this vast area, with bare unforested alpine barrens stretching some miles to the east and farther to the north, while beyond we could see the higher bare-topped tablelands of the Lewis Hills, serpentine, diorite, limestone, and trap, which at their highest points attain an altitude of 2700 feet (800 meters). There was no time to lose, for everywhere about us were most of the species we had first met and had then considered to be rarities on the Marble Mountain, Cow Head, Ingornachoix Bay, or the terraces of Blanc Sablon and Forteau. The western margin of the tableland is mostly dry and shingly (plate 87, fig. 4), but farther back becomes boggy, with small pools and wet runs. On the drier portions of the first low dome of the mountain which we explored the commonest species were *Salix vestita* which is apparently common on all the limestones of western Newfoundland; *Lesquerella arctica,* var. *Purshii,* here in great profusion; *Tofieldia palustris*; a number of strange Euphrasias; *Carex pedata* Wahlenb., a tiny species heretofore unknown south of Greenland and arctic Alaska; *Carex rupestris* All., probably commoner than is supposed, for it abounds on dry limestones of Gaspé as well; *Dryas integrifolia* and a variety with the leaves white-pubescent above (var. *canescens* Simons, previously known only from Ellesmere Land); *Antennaria alpina,* var. *cana*; and the more generally distributed Saxifrages and Arenarias, *Anemone parviflora, Thalictrum alpinum,* etc. The wetter part of this dome was quite boggy, and in the humus and moss we found a few of the ordinary bog plants, which did not venture upon the open limestone gravel.

The drier surface of the second dome visited lacked the *Lesquerella, Carex pedata,* and several other plants which had abounded on the farther side of a narrow wooded sag, but here was a strange *Antennaria* in great profusion — the remarkable plant subsequently described as *A. eucosma,*[1] and as yet known only from this mountain and Anticosti Island, and here were many other plants we had not seen on the first dome: *Woodsia glabella* in the full glare of the alpine light (I had never before seen it except in humus at the crests of woodland cliffs); *Hedysarum alpinum, Oxytropis campestris,* var. *caerulea, Potentilla fruticosa,* var. *tenuifolia* Lehm. forming little prostrate mats upon the rock; and other plants as yet not worked out. In a

[1] Fernald & Wiegand, Rhodora, xiii. 23 (1911).

wet boggy run upon this dome, where we flushed a covey of ptarmigan which started one by one almost from under our feet, were *Kobresia caricina*, *Juncus triglumis*, *Equisetum variegatum*, and other species which we had only occasionally met; but the greatest discovery here was a finely fruited *Carex* which we at once recognized as the long-lost *Carex Hornschuchiana* of Newfoundland. In 1794 Goodenough, in describing from Eaton his *C. fulva*, supplemented the description of the English plant with the comment: "I have received it from *America* and *Newfoundland*, but never understood till very lately that it was an inhabitant of our country." [1] Goodenough's Eaton plant subsequently proved to be a hybrid of one of the forms of *C. flava* and the common European *C. Hornschuchiana* Hoppe, so that the name *C. fulva* is correctly applied only to the hybrid, and the identity of the Newfoundland plant mentioned by Goodenough has remained somewhat vague. The plant of Table Mountain (and also of Hugh's Brook, Bay of Islands, where we subsequently found it) is quite like typical *C. Hornschuchiana* except in size of the perigynia and other minor characters [2] and singularly enough was associated with forms of *C. flava* and a hybrid so like the true *C. fulva* of Goodenough as to differ only in the slightly larger perigynia. The rediscovery of this Newfoundland plant was indeed gratifying, but in view of the occurrence on the limestones of western Newfoundland of a few other plants — *Gentiana nesophila*, *Lesquerella arctica*, var. *Purshii* and *Antennaria eucosma* — which are otherwise known only

[1] Good. Trans. Linn. Soc. ii. 178 (1794).

[2] Carex Hornschuchiana Hoppe, var. **laurentiana** Fernald & Wiegand, n. var., a forma typica recedit habitu majore, foliis basilariis 3–4 mm. latis, culmis 3–6 dm. altis, spicis foemineis crassioris, perigyniis 3.5–4.5 mm. longis.

Differing from the typical form of the species in its larger habit; the basal leaves 3–4 mm. broad; the culms 3–6 dm. high (in the European 3–4.5 dm. high); the pistillate spikes thicker; perigynia 3.5–4.5 mm. long (in the European 3 mm. long).— Newfoundland: wet runs and boggy spots in limestone barrens, altitude 200–300 m., Table Mountain, Port à Port Bay, Aug. 16, 1910, *Fernald & Wiegand*, no. 2897 (type-specimen in Gray Herb.); marsh near the mouth of Hugh's Brook, Bay of Islands, September 6, 1910, *Fernald & Wiegand*, no. 2898. Quebec: peat marsh or bog, Ellis Bay, Anticosti, September 7, 1883, *J. Macoun*, no. 32.

It is possible that var. *laurentiana* will prove to be identical with *Carex Greeniana* Dewey, Am. Jour. Sci. xxx. 61 (1836). The latter plant was "found in the neighborhood of Boston, by B. D. Green[e]; described from specimens in Dr. Torrey's herbarium," and by subsequent authors was said to be *C. fulva*. The specimen preserved in B. D. Greene's own herbarium (at the Boston Society of Natural History) is immature and does not show clearly whether or not the plant is typical *C. Hornschuchiana* or var. *laurentiana*. Nothing of the sort has subsequently been found near Boston and there is a possibility, as has more than once been suggested, that the Greene specimens were a casual introduction from Europe.

on the limestone island of Anticosti,[1] it is interesting to find that the same large-fruited American variety of *Carex Hornschuchiana* was collected in 1883 on Anticosti by Professor John Macoun and was listed in his Catalogue as *C. fulva*, "certainly indigenous."

The discovery of this plant would have made a fitting climax for one of the most thrilling days of our summer, but after we had repeatedly made solemn vows to look at nothing else and were finally hastening back across the barren in order to reach the settlement before dark, an unusual appearing *Senecio* came riding down a mass of sliding gravel to my very feet. This was too great a temptation, so I snatched the plant as it was sliding past and Professor Greenman tells me that it is one of a unique group of species supposed to grow only on the highest of the Rocky Mountains. While hurrying in the twilight down the slope to Port à Port we found damp ledges covered with *Phegopteris Robertiana*, a species rare in America, but quickly distinguished in the field from the common *P. Dryopteris* by its narrower firmer fronds and gray-green color. We were very late to supper but Mrs. MacDonald had a tempting rabbit stew and fresh lettuce ready for us; and next morning, after a breakfast of *Lactarius deliciosus* (which we had never before made a *pièce de résistance*), when we washed and sorted our plants we found that we had collected on Table Mountain 184 species in quantities varying from one to twenty sheets — one of our record days for the summer.

On the way back to Birchy Cove Wiegand and I left the train half way up Harry's River and followed the valley all day from there to the Log Cabin at Spruce Brook, on St. George's Pond. The region traversed was one we had watched with interest from the train, for there in the limy alluvium the plants reached a wonderful degree of luxuriance. The goldenrods, all strange to us and still unidentified except *Solidago rugosa*, var. *villosa*, were shoulder high; *Calamagrostis Pickeringii*, one of the commonest grasses of the island and elsewhere rarely 3 dm. high, was here more than 1 meter tall; *Deschampsia caespitosa*, which elsewhere on the island, as in eastern Canada and New England, is commonly 3 to 6 dm. high, here attained a gigantic stature, the first clump which met our gaze as we descended from the train being 1.5 meters (5 feet) high with panicles nearly 5 dm. long; and in walking through the Ostrich Ferns and Cow Pars-

[1] Certain badly crumbled specimens from Labrador seem to be *Lesquerella arctica*, var. *Purshii*, but better material is needed to confirm its occurrence on that coast.

nips on the river flats we felt like mere pygmies with the latter plants stretching high above our heads. Surely if farming is ever to succeed in Newfoundland, where people have lived for three centuries without seriously attempting it, this is the region which should take the lead — a valley with deep limestone alluvium, with a native vegetation similar to that of "the Aroostook, the Garden of Maine," lying in nearly the same latitude and shut in by hills sufficiently high to afford considerable protection from the bleaker winds. Messrs. Dodd and Paulett, the energetic proprietors of the ill-fated Log Cabin at Spruce Brook (burned during the winter of 1909–10, then rebuilt and burned again last summer) have already demonstrated that this soil will yield wonderful crops, and of all the regions seen by us it seemed the one best worth developing. Many plants common to this region and northern Maine were seen, *Cypripedium hirsutum, Eupatorium purpureum*, var. *foliosum, Cystopteris bulbifera, Trisetum melicoides*; and commonest of all *Carices* in the valley, *Carex flava*, var. *gaspensis* Fernald, first found in the Gaspé Peninsula but later in the rich valley of the Meduxnakeag in Aroostook County.[1] On the gravelly beach of St. George's Pond, as well as along Harry's River, the handsome *Epilobium latifolium* L., was abundant, and at several points we saw the Foxglove, *Digitalis purpurea*, which had spread from the wild garden at Spruce Brook and, Mr. Paulett informed us, has now established itself for five miles around, as it did long ago on the northwestern coast of America.

Leaving the new collections with Kittredge to care for, Wiegand and I went back to the Blomidon tablelands (plate 87, fig. 3). The first day and a half were devoted to the serpentine area, where we followed up many strange plants which still await critical study. *Juniperus communis*, var. *montana*, common everywhere on the island, was now in fully mature fruit and conspicuous for the large size of the berries. *Drosera linearis* was abundant about some of the shallow pools; and we were suddenly struck with the fact that the only fern on the serpentine besides the everywhere abundant *Adiantum pedatum*, var. *aleuticum* was *Osmunda regalis*, a species we had observed hardly anywhere else on the island, though others have found it in the more sterile sections. But here the plants were anything but regal, 1.5 to 3 dm. high, with the very short oblong pinnules

[1] See Rhodora, xii. 115 (1910).

quite different in their proportions from those of the ordinary plant. A study of the serpentine plant shows it to be *O. regalis*, var. *pumila* described by Milde and taken up by Luerssen as a constant variation known only from Brandenburg and Silesia.

Foot-travel in Newfoundland, except on the beaten trails and open tablelands, is notoriously difficult, and the Blomidon talus-slopes are no exception. At the end of the first day Wiegand had succeeded in bruising one of his feet so that next morning I started, accompanied only by our packer, a particularly foul-smelling "Jacky Tar" as the French of this coast are called, for the diorite tableland which lay a few miles to the west of our camp. It was necessary practically to climb the slope of the intermediate serpentine tableland, then to descend 1500 feet to the bed of Blomidon Brook and up the other side which was diorite. The freshly broken talus was slightly calcareous and had some of the common calciphiles, but the weathered rock from which the soluble lime had leached was carpeted in patches with the plants we are used to on our granitic mountains, and *Phyllodoce caerulea* was here seen for the first time in the entire summer and *Stipa canadensis* was apparently new to the island. Here were no signs of the plants of the serpentine which abounded only a short distance to the east, and much of the tableland was wooded and covered with a dense carpet of moss and humus. Ponds and shallow pools were everywhere and I was glad to find in one of them *Callitriche anceps* Fernald[1] which was discovered in 1906 in ponds on Tabletop Mountain, Gaspé, and which we had found also in Blanc Sablon River. *Drosera anglica* was common as were many plants which earlier in the summer had been quite new to us; but the species which interested me most were two which seemed entirely out of place in this subalpine habitat. Among the tufts of *Scirpus caespitosus* which, as on many similar barrens, formed broad carpets in the drier portions of the bogs, was the famous little fern of the New Jersey Pine Barrens, *Schizaea pusilla*, already known in Newfoundland from collections of la Pylaie, Waghorne, and Eames & Godfrey and after we had once seen it found wherever we looked for it; also known at remote stations in Nova Scotia, but quite unknown between there and southern New Jersey. Here at 2000 feet altitude it abounded over many acres, nestling in the bases of the *Scirpus* tussocks; while in many

[1] Rhodora, x. 51 (1908).

of the shallow ponds *Potamogeton Oakesianus,* another New Jersey species and one of the commonest of its genus on Nantucket and Cape Cod, though unknown in eastern Maine, New Brunswick and Nova Scotia, was fruiting profusely.

Long before dark I had followed Wiegand's unfortunate example of the day before and came into camp hobbling on one foot and a heel. He, fortunately, was on both feet again, but when we got back to Birchy Cove and the doctor found that I had cracked the tendon of my little toe I was laid aside for repairs and it was nearly two weeks before I ventured off the piazza. Wiegand and Kittredge meanwhile went on the "Home" to Bonne Bay, by many said to be the most picturesque fiord south of northern Labrador. This trip had been one of my fondest hopes, for the mountains about Bonne Bay are a duplication of those about the Bay of Islands and years ago, when I first read Logan's account of Bonne Bay, I had set my heart on sometime making a comparison of that region and the Bay of Islands area. But, although it was necessary to delegate to others this part of the work, my enforced housing brought the great pleasure of at last making the acquaintance of the paleontologist, Professor Charles Schuchert who, with his companion (making up the "Yale Expedition" of the Newfoundland papers) had been studying all summer much the same region as the "Harvard Expedition," but whom we had always preceded or immediately followed at our various centers of work.

In less than a week Kittredge returned bringing part of the Bonne Bay collections, but the "hoodoo" was still with us. Kittredge was yellow with jaundice and soon returned to Boston and a less strenuous life. Wiegand, after leaving Bonne Bay, had gone north to Blanc Sablon whence he returned without mishap bringing the remainder of the Bonne Bay collections. These, in brief, were an exact duplication of the Blomidon plants, the Bonne Bay serpentines yielding the *Adiantum, Osmunda, Danthonia, Lychnis, Arenaria arctica* and *A. ciliata,* var. *humifusa, Statice,* and all the others (except perhaps *Festuca scabrella* which it was now too late to collect); Lookout Mountain, the Bonne Bay counterpart of the diorite portion of the Blomidon Range yielding *Schizaea pusilla, Potamogeton Oakesianus* and two plants we had not before seen: *Sparganium hyperboreum,* found by Eames and Godfrey on the Blomidon diorite; and *Eleocharis nitida,* a little sedge heretofore known only from the diorite region at the head of the Ottawa River in Canada.

Thus I have recounted some of our discoveries and have as briefly as possible, though I fear at too great length, tried to give some impression of our more notable days of field-work during the past summer. Many unchronicled days yielded important results and after determining all the plants we can by matching in the herbarium and by the ordinary works of reference we have a stack of "snags" in many tight bundles awaiting monographic study. And if I have laid no stress on the abundance of insect pests which Newfoundland shares with Gaspé, Anticosti, Labrador and New Jersey, it is because we soon grew accustomed to our veils and canopies and took them as mere incidents in a thoroughly absorbing summer.

Part II. The Geographic Origin of the Flora of Newfoundland.

There are many comparisons which it would be interesting to make: of the flora of the west coast, for example, with that of the east as shown by the collections of Waghorne, Robinson and Schrenk, Howe and Lang, Sornborger, and others, but we still know too little of the detailed distribution to undertake such generalizations with assurance. Certain facts of wider scope, however, are so obvious as to challenge immediate explanation. As we have seen, the boreal and even the arctic floras are abundantly represented in Newfoundland; and, especially in the sandy areas or in the bogs on the Carboniferous sandstones the plants of southern New England, Long Island, New Jersey, and even of the more southern Coastal Plain are abundant,— such species as *Panicum implicatum*, *Ammophila arenaria* (found also on the sand dunes west of Blanc Sablon), *Scirpus subterminalis*, *Carex silicea*, *C. hormathodes*, *C. sterilis* (*atlantica*), *C. trisperma*, var. *Billingsii*, *Eriocaulon septangulare*, *Juncus pelocarpus*, *Habenaria blephariglottis*, *Spergularia rubra*, *Arenaria peploides*, var. *robusta*,[1] *Pyrus arbutifolia*, var. *atropurpurea*, *Corema Conradii*, *Elatine americana*, *Hudsonia ericoides*, *Myriophyllum tenellum*, *Vaccinium macrocarpon*, *Gaylussacia dumosa*, var. *Bigeloviana*, *Utricularia clandestina*, *Solidago uniligulata*, *Aster radula* and *A. nemoralis*; while there and even on the highest mountain-tablelands *Schizaea pusilla*, *Potamogeton Oakesi-*

[1] See Rhodora, xi. 114 (1909).

anus, and *Rynchospora fusca* of our southern coasts are mingled with arctic-alpine species. These two elements, the arctic-alpine and the southern coastal types are, then, abundant; but when we look for the commonest plants which abound in all the forested area west of Newfoundland, from eastern Quebec, New Brunswick, and Nova Scotia to the Great Lakes, i. e. the typical Canadian species, we find them singularly few in number.

These facts become more vivid when we map the known distribution in eastern America of the species which make up the native flora of Newfoundland. So far as we yet know, the indigenous species and recognized varieties on the island number 783, while there are about 200 species clearly introduced by man. The indigenous plants when traced throughout their known continental ranges fall into four primary classes distinguished from their geographic position (in relation to Newfoundland) as:

Class I. Boreal Types.

Class II. Western or Canadian Types not included in I.

Class III. Southwestern Types.

Class IV. Endemic Plants or Species unknown on the American Continent.

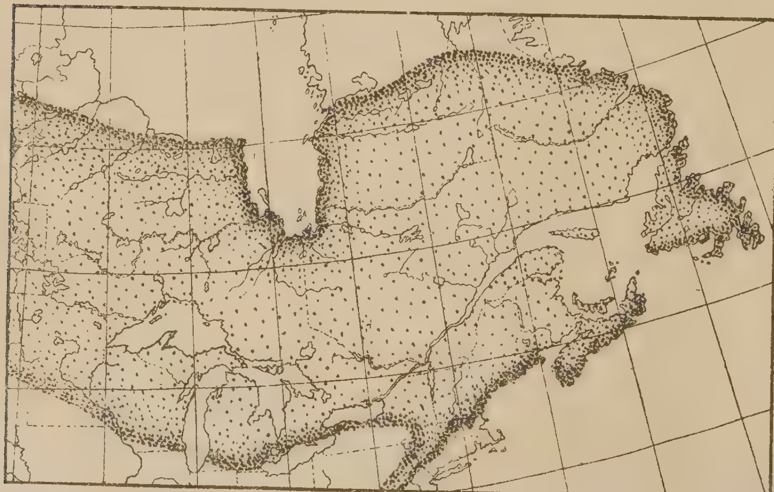
These major floras may be further defined and subdivided as follows:

CLASS I. BOREAL TYPES. Here are included all species which occur to the north of Newfoundland: in Labrador proper, Baffin Land, Ellesmere Land or Greenland or in the arctic-alpine regions farther west. In their detailed distribution these plants fall into four subclasses which together include **466 species = 59$\frac{2}{5}$ per cent** of the Newfoundland flora.

Subclass A. Arctic-alpine species common to Newfoundland, Labrador, and eastern Canada (the Gaspé Peninsula or the more exposed portions of New Brunswick and Nova Scotia). **216 species = 27$\frac{3}{5}$ per cent** of the Newfoundland flora.

This large group includes such familiar plants of our higher Canadian or New England mountains as *Lycopodium Selago*, *Phleum alpinum*, *Calamagrostis hyperborea*, *Poa alpina*, *Scirpus caespitosus*, *Carex rariflora*, *Juncus trifidus*, *Tofieldia palustris*, *Salix Uva-ursi*, *Betula glandulosa*, *Arenaria arctica*, *Lychnis alpina*, *Thalictrum alpinum*, *Dryas integrifolia*, *Empetrum nigrum*, *Rhododendron lapponicum*, *Phyllodoce caerulea*, *Arctostaphylos alpina*, *Diapensia lapponica*, and *Pinguicula vulgaris;* and their range in America is fairly typified by the Mountain Cranberry (*Vaccinium Vitis-Idaea*, var. *minus*) which is common from

5. DISTRIBUTION OF VACCINIUM VITIS-IDAEA, VAR. MINUS.



6. DISTRIBUTION OF RIBES PROSTRATUM.

Newfoundland and the North Shore of the St. Lawrence northward, but south of the lower St. Lawrence is restricted to the more exposed mountains, high hills, rock-coasts and cold bogs. The range of this plant in eastern America is shown in plate 88, fig. 5.[1]

SUBCLASS B. ARCTIC-ALPINE SPECIES COMMON TO NEWFOUNDLAND AND LABRADOR (OR GREENLAND) BUT UNKNOWN IN EASTERN CANADA OR NEW ENGLAND. **16 species = 2 per cent** of the Newfoundland flora.

This subclass includes widely distributed polar species all of which are likely to be found on Anticosti or the Gaspé Peninsula: such plants as *Hordeum boreale*, *Kobresia caricina*, *Carex pedata*, *Juncus triglumis*, *Capsella elliptica* C. A. Meyer, *Cochlearia anglica*, *Potentilla maculata*, and *Antennaria alpina*, var. *cana*.

SUBCLASS C. ARCTIC-ALPINE SPECIES KNOWN IN VARIOUS SECTIONS OF NORTHERN CANADA OR ALASKA BUT AS YET UNKNOWN IN LABRADOR PROPER. **16 species = 2 per cent** of the Newfoundland flora.

These are mostly plants confined to the highly magnesian rocks (serpentine, etc.), areas which because of their extreme sterility are rarely visited by those who are looking for plants. The magnesian areas of Labrador, when explored, will doubtless yield these plants: such species and varieties as *Adiantum pedatum*, var. *aleuticum*, *Danthonia intermedia* and *Festuca scabrella*.

SUBCLASS D. HUDSONIAN OR CANADIAN PLANTS COMMON TO NEWFOUNDLAND, SOUTHERN OR FORESTED LABRADOR, AND EASTERN CANADA. **218 species = $27\frac{4}{5}$ per cent** of the Newfoundland flora.

It is naturally difficult to draw a definite line between the Arctic-alpine and the Hudsonian plants on the one hand and the Hudsonian and Canadian on the other, for in such regions as Newfoundland and eastern Canada these groups mingle in the most perplexing fashion. The plants of Subclass D are probably chiefly Hudsonian for they extend across the Labrador Peninsula to the Atlantic coast or the Straits of Belle Isle, but this subclass contains a number of species, already enumerated on p. 125, which are ordinarily of more southern range and belong more properly to the Canadian or even the Alleghanian flora. **The significant point for the present study is the fact that these 218 plants of Subclass D occur north of Newfoundland, in Labrador**. This large group includes, besides the species listed on p. 125, such very familiar species as *Cryptagramma Stelleri*, *Dryopteris Filix-mas*, *Lycopodium complanatum* (true), *Larix laricina*, *Picea canadensis*, *P.*

[1] The maps here reproduced show the broad range of the species but do not attempr to indicate exact stations.

mariana, Abies balsamea, Triglochin palustris, Scirpus hudsonianus, S. atrocinctus, Eriophorum gracile, Carex Michauxiana, Habenaria hyperborea, H. dilatata, H. obtusata, Spiranthes Romanzoffiana, Listera cordata, Salix balsamifera, S. candida, Populus balsamifera, Betula pumila, Drosera rotundifolia, Parnassia parviflora, Ribes lacustre, R. prostratum, R. triste, Pyrus sitchensis, Amelanchier oligocarpa, Geum macrophyllum, Epilobium angustifolium, Circaea alpina, Osmorhiza obtusa, Heracleum lanatum, Cornus canadensis, Pyrola minor, Primula farinosa, var. *macropoda, Halenia deflexa, Galium labradoricum, Viburnum pauciflorum* and *Solidago macrophylla.* A good conception of the broad range of this group is gained from the map (plate 88, fig. 6) showing the distribution in eastern America of the Skunk Currant (*Ribes prostratum*).

CLASS II. WESTERN OR CANADIAN TYPES NOT REACHING LABRADOR. **27 species = $3\frac{1}{2}$ per cent** of the Newfoundland Flora.

These plants occur on the west side of the Gulf of St. Lawrence (in northern Nova Scotia, New Brunswick, the Gaspé Peninsula and adjacent area or on Anticosti) but are unknown in central and southern Nova Scotia, coastal Massachusetts, Long Island and eastern and southern New Jersey. From the following list, which includes all of the species of Class II, it will be seen that many of these plants are such as by further exploration are likely to be discovered in Labrador, when they will take their places in Class I; and that none of them are characteristic (if found at all) in the southern half of Nova Scotia and the coastal region southward.[1] *Potamogeton filiformis, Trisetum melicoides, Eleocharis nitida,*[2] *Scirpus pauciflorus, Carex eburnea, Carex flava,* var. *gaspensis, C. Hornschuchiana,* var. *laurentiana,*[3] *Carex castanea, Juncus compressus* Jacq., *Juncus alpinus,* var. *insignis, Tofieldia glutinosa, Zigadenus chloranthus, Listera auriculata, L. convallarioides, Salix glaucophylla, S. Barclayi, Polygonum Roberti* Loisel.,[4] *Ranunculus Macounii, Ribes hirtellum,* var. *saxosum,*[5] *Viola nephrophylla, Shepherdia canadensis, Pyrola asarifolia,* var. *incarnata, Gentiana nesophila, Galium kamtschaticum, Lobelia Kalmii, Antennaria eucosma,*[6] and *Tanacetum huronense.*

CLASS III. SOUTHWESTERN TYPES. This class contains **274 species = 35 per cent** of the Newfoundland flora. It consists of

[1] For notes on *Lesquerella arctica,* var. *Purshii* see p. 131.

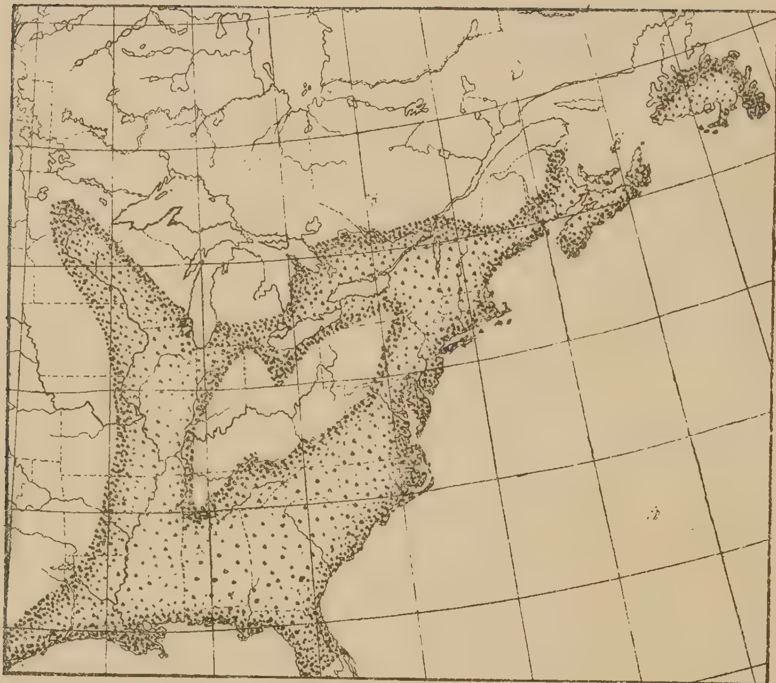
[2] Known as yet only from western Newfoundland and the upper Ottawa River (see p. 134).

[3] There is a possibility that this was once found in eastern Massachusetts (see p. 130).

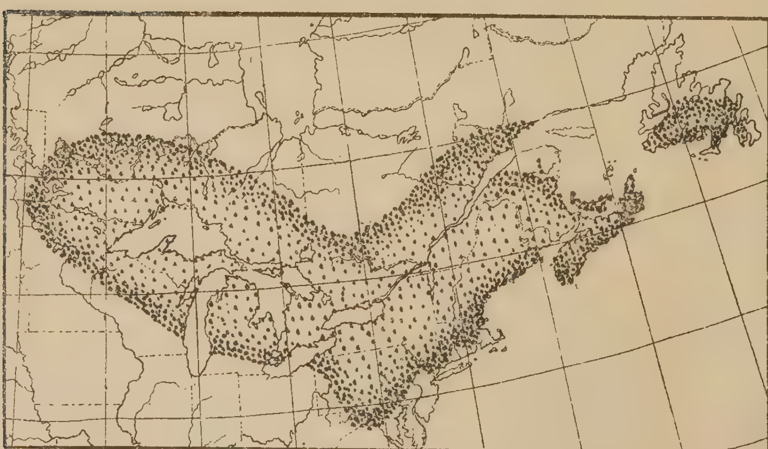
[4] *Polygonum Roberti* has been collected at the Grand Narrows, Cape Breton (*Macoun,* no. 20,206).

[5] See Rhodora, xiii. 75, 76 (1911).

[6] See Rhodora, xiii. 23 (1911).



7. Distribution of Calopogon pulchellus.



8. Distribution of Pinus resinosa.

plants found chiefly in regions to the southwest of Newfoundland and may be divided into two subclasses.

Subclass A. Canadian and Alleghanian Plants common to Newfoundland, Nova Scotia, New Brunswick, and coastwise New England but unknown in easternmost Quebec or Labrador. **214 species = 27⅓ per cent** of the Newfoundland flora.

It is not possible in our northeastern regions to distinguish sharply between the Canadian and Alleghanian floras. Many plants such as *Onoclea sensibilis*, *Osmunda cinnamomea*, *Pinus Strobus*, *Cypripedium acaule*, *Salix humilis*, *Spiraea latifolia*, *Acer rubrum*, *Aralia hispida*, *Pyrola americana*, *Epigaea repens*, *Lysimachia terrestris*, and *Solidago rugosa* abound in both regions and very often encroach upon the Carolinian area. In placing species in Subclass A no distinction has been made between Canadian and Alleghanian; **but the significant point in regard to this large group is that its species occur in the North Atlantic States, Nova Scotia, and often New Brunswick, are rare or unknown on the Gaspé Peninsula or Anticosti, and reach their northeastern limit on the continent in western Saguenay County, Quebec, 400–500 miles west of the Straits of Belle Isle**.

Besides the species just enumerated this group contains such very familiar plants as *Dryopteris cristata*, *Lycopodium complanatum*, var. *flabelliforme*, *Pinus resinosa*, *Panicum boreale*, *Oryzopsis asperifolia*, *Glyceria canadensis*, *Elymus virginicus*, *Scirpus georgianus*, *Rynchospora fusca*, *Carex vulpinoidea*, *Juncus effusus*, var. *Pylaei*,[1] *J. canadensis*, *Trillium cernuum*, *Calopogon pulchellus*, *Pogonia ophioglossoides*, *Arethusa bulbosa*, *Salix discolor*, *Polygonum sagittatum*, *Pyrus melanocarpa*, *Rosa virginiana*, *Ilex verticillata*, *Oenothera pumila*, *Cicuta bulbifera*, *Gaultheria procumbens*, *Gaylussacia baccata*, *Vaccinium macrocarpon*, *Apocynum androsaemifolium*, *Lycopus uniflorus*, *Viburnum cassinoides*, *Lobelia Dortmanna*, *Eupatorium purpureum*, var. *maculatum*, *Aster nemoralis*, *A. umbellatus*, and *Antennaria neodioica*. As good representatives as any of the distribution of Subclass A are the familiar bog orchid, *Calopogon pulchellus*, the range of which is shown in plate 89, fig. 7, and the Red or Norway Pine, *Pinus resinosa*, the range shown in plate 89, fig. 8.

Subclass B. Carolinian Plants common to Newfoundland, Nova Scotia, Cape Cod and adjacent islands, Long Island, or coastal and southern New Jersey, but rare or unknown inland or in continental eastern Canada. **60 species = 7⅔ per cent** of the Newfoundland flora.

[1] See Rhodora, xii. 92 (1910).

The plants of Subclass B are more restricted in their distribution than the more southerly elements of Subclass A, being confined to the silicious and boggy coastal strip represented by the New Jersey Pine Barrens, southern and eastern Long Island, Cape Cod and adjacent coasts, sandy portions of Nova Scotia, Sable Island, and silicious and other sterile areas of Newfoundland, only in the most exceptional cases found far inland or northward in New England or eastern Canada. Several of these plants are enumerated on p. 135, among the most notable of them being *Schizaea pusilla, Potamogeton Oakesianus, Ammophila arenaria, Carex hormathodes, C. silicea, C. sterilis, Juncus effusus,* var. *conglomeratus* Engelm. (known in America only from eastern Newfoundland, southeastern Connecticut, and the Pine Barrens of New Jersey), *Spergularia rubra, Arenaria peploides,* var. *robusta, Corema Conradii, Elatine americana, Hudsonia ericoides, Myriophyllum tenellum, Gaylussacia dumosa,* var. *Bigeloviana,* and *Utricularia clandestina.* The distribution of this group is represented on plate 90, showing the ranges of *Schizaea pusilla* (fig. 9) and of *Corema Conradii* (fig. 10).

CLASS IV. ENDEMIC PLANTS OR SPECIES UNKNOWN ON THE AMERICAN CONTINENT. A small class, **16 plants = 2 per cent** of the Newfoundland flora, divided into

Subclass A. Endemic Plants. **8 plants = 1 per cent** of the Newfoundland flora, chiefly varieties of continental types.

Subclass B. Old World Types as yet unknown on the American Continent. **8 species = 1 per cent** of the Newfoundland flora.

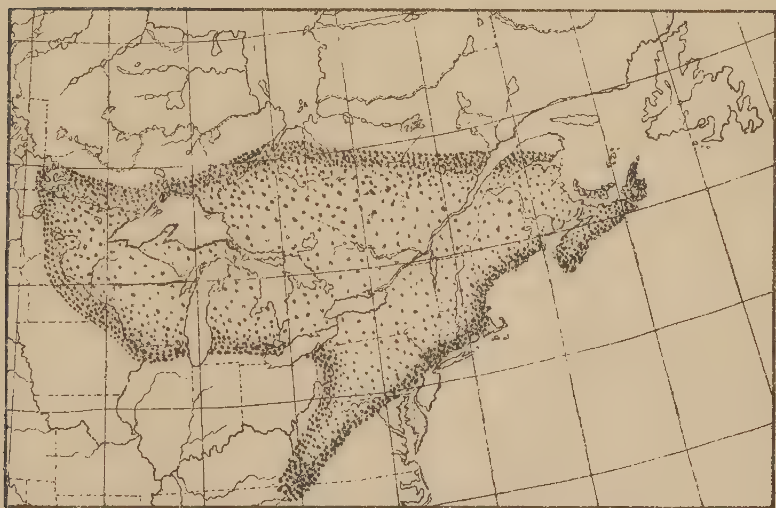
These plants, such species as *Montia rivularis* Gmel., *Saxifraga Geum* L., etc., are mostly either technical or obscure boreal species which are likely to be found in Labrador or are known from Greenland.

Briefly summarized, the analysis of the indigenous flora is

Class	No. of Plants	Per cent of Indigenous Flora
Class I. Boreal Types	466	$59\frac{1}{2}$
Class II. Western or Canadian Types not reaching Labrador	27	$3\frac{1}{2}$
Class III. Southwestern Types	274	35
Class IV. Endemic Plants or Species Unknown on the Continent	16	2
	783	100

9. Distribution of Schizaea pusilla.

10. Distribution of Corema Conradii.



11. Distribution of Aster macrophyllus.

The striking feature of this analysis is of course, as already stated, the fact that of the indigenous plants of Newfoundland $94\frac{1}{2}$ per cent are identical either with species found to the north of the Straits of Belle Isle or with plants which occur along the Atlantic seaboard to the southwest; while only $3\frac{1}{2}$ per cent are most typically Canadian plants which on the continent find their greatest development in latitudes and climatic zones parallel with those of central and southern Newfoundland. As previously suggested a very large proportion (340 + species) of the plants which abound on the continent at the western edge of the Gulf of St. Lawrence and which we should expect to find in appropriate habitats in Newfoundland seem to be quite absent from the island. I have spoken (p.115) of the absence from the calcareous valleys of Arbor Vitae and some of its regular associates. Besides these we have searched for in vain and others have failed to find in Newfoundland such very familiar species as *Adiantum pedatum*,[1] *Dryopteris marginalis, Sagittaria latifolia, S. arifolia, Alisma Plantago-aquatica, Poa Sandbergi* Vasey (one of the most abundant grasses on calcareous rocks of the Gaspé Peninsula), *Eleocharis obtusa, Carex stricta, C. lurida, C. retrorsa, Arisaema triphyllum, Veratrum viride, Lilium canadense, Trillium erectum, T. undulatum, Populus grandidentata, Ostrya virginica, Quercus rubra, Polygonum cilinode, Anemone riparia, A. canadensis, Clematis virginiana, Corydalis sempervirens Penthorum sedoides, Tiarella cordifolia, Chrysosplenium americanum, Dryas Drummondii* Richardson (which, in the Silurian regions of Anticosti and the Gaspé Peninsula, covers the river-gravels), *Prunus pumila, Dalibarda repens, Acer Saccharum, Viola septentrionalis, Pyrola asarifolia*,[2] *Steironema ciliatum, Mimulus ringens, Lonicera canadensis, Sambucus canadensis, Viburnum alnifolium, Eupatorium urticaefolium, Solidago squarrosa, Aster macrophyllus, A. acuminatus, Erigeron philadelphicus, Bidens cernua,* and *Prenanthes altissima*; these, as just said, only a few of the most conspicuous of 340 + such

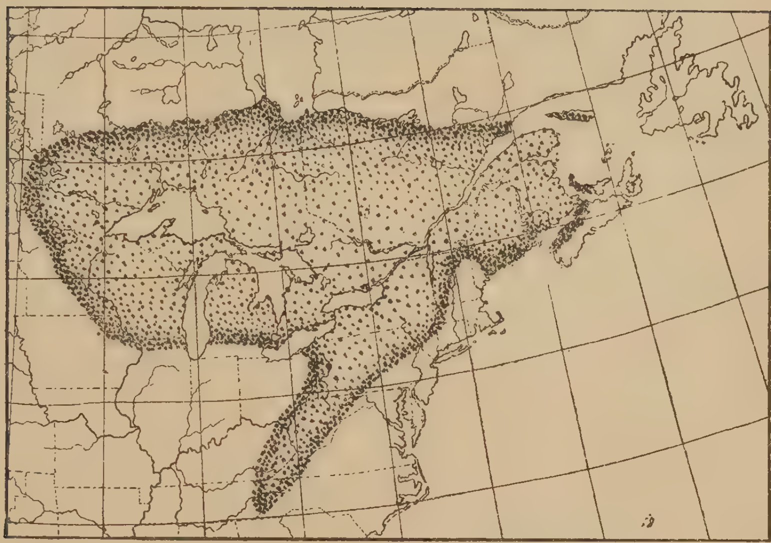
[1] La Pylaie naïvely states that the mountains north of Hare Bay have been named *Montagne du Capillaire*, because of the abundance there of *Adiantum pedatum* (Voyage, 3); but in Newfoundland the name *Capillare* is so generally used for *Chiogenes*, from the berries of which a highly esteemed preserve is made, that it is probable that this fruit was more concerned than *Adiantum* with the naming of the mountains. The only *Adiantum* known in Newfoundland is *A. pedatum*, var. *aleuticum* which is common on the serpentine barrens.

[2] *P. asarifolia*, var. *incarnata* which is a more northerly plant than typical *P. asarifolia* occurs in western Newfoundland.

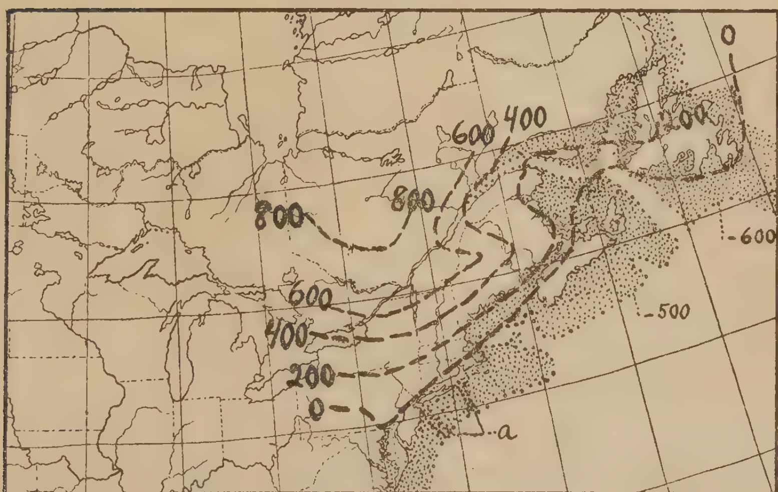
species, a large flora which on the continent occupies a fairly definite and broad belt between the Hudsonian element of Class I and the group of species embraced in Class III. Typical ranges of these Canadian plants are shown in plates 90 and 91, indicating the distribution of *Aster macrophyllus* (fig. 11), perhaps the most common Aster of the eastern Canadian forests, and of the Arbor Vitae, *Thuja occidentalis* (fig. 12), one of the most abundant and valuable trees of eastern Canada.

Here indeed is an anomalous situation. Although from the insular position of Newfoundland we should naturally expect that her flora would lack many species, it is certainly by more than a mere coincidence that the island lacks a large proportion of the most typical plants which on the mainland to the west abound in similar latitudes and under essentially identical conditions of climate and soil, but at the same time possesses so large a proportion of the Arctic-alpine flora mingled, often in closest proximity, with plants characteristic of southern New England, and even of the Cretaceous and Tertiary clays and sands of the New Jersey Pine Barrens. The presence on the island of the 466 Boreal plants of Class I ($59\frac{1}{2}$ per cent of the whole flora) is apparently simple to explain, for the northern peninsula of Newfoundland is separated from the Labrador Peninsula merely by the Straits of Belle Isle which are in many places only 11 or 12 miles across. The endemic plants and those not known upon the continent of North America (Class IV) may also be passed for the present since, when that country is better known, the latter will presumably be found in Labrador, and since the endemic plants are without exception minor variants or immediate relatives of continental types, showing that the flora of the island is of comparatively recent origin; in this resembling the flora of the Faeröes, a region which, as Warming states, forms "a strong contrast to other Atlantic islands, viz. the Azores, Madeira, and the Canaries, which are rich in endemic species, and have a flora which is very old, related to that of the Tertiary time; this can only be accounted for by the fact that no Glacial Period destroyed the old plant-world of these islands." [1] The greatest problem, and the only one with which we will at present deal, concerns Classes II and III, the typical Canadian flora which is very meagrely represented in Newfoundland, and the somewhat

[1] Warming: The History of the Flora of the Faeröes. Botany of the Faeröes, ii. 662 (1903).



12. Distribution of Thuja occidentalis.



13. Copy of a portion of de Geer's Map of the last Change of Level in Eastern North America. Broken lines are Isobases with 200 foot interval. Dotted portion, the submerged Coastal Plain. a. Submarine River-channels.

more Southwestern plants which together with the Boreal make up $94\frac{1}{2}$ per cent of the flora of the island; a flora which, it is almost needless to say, must have reached Newfoundland since the receding toward the north of the Pleistocene glaciers.

Besides by human transportation there are five methods by which plants are commonly supposed to have reached islands: by transportation by birds, by ocean-currents, by floating ice and logs, by winds, or by having crossed on a formerly existing land-bridge. All of these methods may well have been effective in bringing to Newfoundland the plants of Group I, the Boreal types, but before accepting them as the sources of the floras of Groups II and III, the typical Canadian and the Southwestern plants, we may well consider them in some detail.

Birds. There has long been a strong tendency, based in part on the notes of Darwin and others, to believe that many difficult problems of plant distribution are to be explained by assuming that the seeds or fragments of the plants have been transported by birds. But it can only be said that the best evidence is opposed to this explanation of the origin of the floras of the more remote islands of the North Atlantic. In their exhaustive treatises on the sources of the Faeröese flora Warming and Ostenfeld, though diametrically opposed in their final opinions (the latter urging the necessity of a post-glacial land-bridge from Scotland to the Faeröes, the former maintaining that no such bridge is demanded), both affirm that the number of plants carried by birds over such distances ~~are~~ almost negligible. This conclusion is based upon the studies of two eminent Danish ornithologists and is so applicable to the present problem that I quote freely from both Ostenfeld and Warming. The former says:

"As I also [formerly] laid some stress on the migrations of birds (all the more, perhaps, because I held the other disseminating agencies to be of little value) I applied to an eminent Danish ornithologist, Mr. Knud Andersen, who has made a special study of the birds of the Faeröes,[1] and he very kindly gave me the information I wanted. .... If we consider how the migrating birds would carry the seeds with them, it can only be in one of two different ways, either in the alimentary canals or adhering to their beaks, feet or feathers. With

[1] Knud Andersen: Meddelelser om Faerøernes Fugle med saerligt Hensyn til Nolsø, I and II. (Vidensk. Medd. f. d. naturh. Forening i Kjøbenhavn 1898, p. 315, 1899, p. 239).

regard to this Mr. Andersen says that in Denmark during a period of 4–5 years the intestines of all the birds found at the lighthouses were examined with the result that all without exception were empty, i. e. *the birds migrate on an empty stomach.* Even if a bird had taken food just before it left the nearest land, Shetland, it would not retain it until it reached the Faeröes, as it takes at most a few hours to digest the food and the useless parts are doubtless ejected during flight. With regard to the seeds adhering to the birds, Mr. Andersen says that here also we must bear in mind that we are speaking of migrating birds, for while a bird shot in the fields may have clumps of earth, etc. (possibly with seeds) adhering to it, this has never been found to be the case with migratory birds on the move, and he again refers to the quantity of birds from lighthouses which he has had for investigation to support him in stating with some certainty that *migratory birds are almost always clean when they journey.*"

"'Thus we see that an ornithologist is of opinion that *migratory birds are of hardly any importance as disseminators of plants.*" [1]

Warming, referring to Andersen's conclusions, supplements them with the conclusions of the Danish zoologist, Winge:

"'For a number of consecutive years thousands of birds, picked up dead at the Danish lighthouses, have been sent to the Zoological Museum in Copenhagen, and notes on these dead birds have for many years been published annually by H. Winge in 'Videnskabelige Meddelelser fra Naturhist. Forening.' This eminent zoologist writes to me, in a letter dated March 27, 1903, as follows:— 'In one of the first years, the contents of the stomachs were systematically examined, later on only occasionally, but the stomach has always proved to be empty, only rarely some very slight traces of food have been found, viz. small pieces of the testa of seeds, etc. (besides, in some cases, a little sand or small stones, etc.). Though I have had thousands of dead migratory birds between my hands, and have made a habit of examining every single one, I have not as yet found any seeds adhering to the feathers, beaks, or feet. Small crusts or lumps of dried mud or clay occur fairly often on the beaks and feet of birds such as wading-birds, larks, starlings, etc.; whether these crusts or lumps contain microscopical germs, has not yet been ascertained (they may undoubtedly do so), but seeds, such as may be discerned by the naked eye or with a pocket-lens, have not been found.'"

[1] Ostenfeld, Botany of the Faeröes, i. 116, 117 (1901).

"As the above observations are made by so careful and eminent an investigator, I must consequently believe that birds at least very seldom carry seeds and other larger reproductive organs, and small plants, across great distances, and the indisputable evidences of birds carrying seeds either in them or adhering to them mentioned in books evidently apply to birds shot at or not far from, their daily haunts, and not to such as have just made a long journey. Winge also has observed a great many instances of birds carrying seeds across short distances."[1]

In view of the well known character of the work of Andersen and of Winge and the fact that it is confidently relied upon by so distinguished an advocate of the land-bridge theory as Ostenfeld and by the illustrious opponent of that theory, Warming, we can do no better than to acquiesce in their conclusion, that some method other than transportation by birds is required to account for the vascular flora of the Faeröes; and to conclude that in the case of the Newfoundland vascular plants (or at least of most of them) we must also seek a better explanation.

Ocean Currents. The most pronounced of the ocean-currents which skirt the eastern coast of North America are of course the Gulf Stream which as it drifts eastward off the coast of eastern New England, Nova Scotia and Newfoundland is far out to sea, and the Labrador Current which, coming from the North, is the shoreward current along the outer coast of Newfoundland, Nova Scotia and eastern New England. That the plants of New Jersey, coastwise New England and southern Nova Scotia could not reach Newfoundland by means of the south-flowing shoreward Labrador current needs no argument; and that the Gulf Stream, far offshore and washing no part of our coast north of the West Indies would be ineffective is perfectly obvious. Nor is Cabot Strait, the water separating Newfoundland from Cape Breton, adapted to transport seeds from the latter to the former region for, as shown by W. B. Dawson, the strong trend of the currents on the western or Nova Scotia side of this Strait is from the Gulf of St. Lawrence out to the open Atlantic; but on the eastern or Newfoundland side from the Atlantic into the Gulf.[1] And the very meagre representation in Newfoundland of the characteristic Canadian plants (27 species out of more than 367) which

[1] Warming, Botany of the Faeröes, ii. 676, 677 (1903).

abound on the west side of the Gulf of St. Lawrence shows clearly how ineffective have been the waters of the Gulf in transporting plants from Anticosti, the Gaspé Peninsula, New Brunswick and Cape Breton to the Newfoundland shores. Even the current of the gigantic lower St. Lawrence River has been surprisingly ineffective in this transportation, for not only do the 340 typical Canadian plants which are unknown in Newfoundland nearly all occur along the lower St. Lawrence whence, theoretically, their seeds, fruits or other fragments might be washed to the Newfoundland side of the Gulf; but of the 274 species which comprise our Class III, the Southwestern plants, not any of those which grow along the upper St. Lawrence but are unknown in easternmost Quebec show, so far as indicated by my daily recorded observations for many summers on the lower St. Lawrence, any evidence of extending their ranges from their continuous areas of distribution to points farther down the river. Many other plants, furthermore, such as *Dryopteris cristata, Pinus resinosa, Carex vulpinoidea, Juncus tenuis, Salix humilis, Spiraea latifolia, Rosa virginiana, Ilex verticillata, Hypericum boreale, H. virginicum, Aralia hispida, Sium cicutaefolium, Cornus circinata, Pyrola americana, Scutellaria galericulata, Chelone glabra, Viburnum cassinoides,* and *Solidago rugosa,* while extending in a comparatively solid phalanx across New England and southern Quebec as far east as Temiscouata, Rimouski or western Matane County, where the St. Lawrence has become sea-like and decidedly saline, have failed to find successful anchorage farther down the St. Lawrence, along the north shore of the Gaspé Peninsula or on Anticosti Island, although many of them extend northward along the coast from eastern New Brunswick to the north shore of the Baie des Chaleurs. This fact is further emphasized by an examination of Dr. Schmitt's catalogue of the vascular plants of Anticosti,[2] which enumerates a large number of species but, with the possible exception of *Diervilla Lonicera,* not one of them such as seem to have been stranded on the island from areas far up the St. Lawrence.[3] It is thus apparent that, although our small rivers are

[1] See A. T. Drummond: Currents and Temperatures in the Gulf of St. Lawrence. Can. Rec. Sci., vii. 54 (1896).

[2] Schmitt, Monographie de l'ile d'Anticosti, 159–234 (1904).

[3] Schmitt's *Ranunculus Harveyi, Thalictrum divicum* [*dioicum*], *T. purpurascens,* and *Viola rostrata* are unquestionably listed though errors of determination, since these are all plants of far more southern or inland areas. His *Ranunculus Harveyi* (real *R. Harveyi* is confined to Missouri and Arkansas) is possibly *R. Allenii* Robinson; his

often highly efficient in transporting and distributing plants or their fragments or fruits, the broad lower St. Lawrence, like a great drifting sea, accomplishes little toward populating the shores near its mouth with the plants from farther up-stream; and in this service not only the current of the St. Lawrence but the currents in the Gulf have been conspicuously ineffective in carrying to Newfoundland the plants which abound on the continent.

Floating Ice and Logs. These may well be efficient in bringing boreal plants upon the coast of Newfoundland, but for the reasons explained in the consideration of ocean-currents they apparently have carried few if any southwestern types to the island.

Winds. Warming feels that in case of the Faeröes winds are sufficient to have carried upon those islands most of the plants they have received from Scotland, but Ostenfeld urges that many species have seeds too heavy for ready transportation by this means. In the case of Newfoundland it is perfectly reasonable to suppose that the plants of Class I, the Boreal Species, which, as we have seen, might readily be brought from the Labrador side of the Straits of Belle Isle by birds, ocean-currents or floating ice and logs, could as readily have been transported by the winds; for the distance is so slight that the light seed (or spores) — of *Botrychium Lunaria, Lycopodium Selago, Eriophorum Chamissonis, Salix, Populus balsamifera,* etc.— might readily be wafted across, and the dried fragments or heavier fruits of other plants blown across on the comparatively short ice-bridge formed in severe winters. But the distance across Cabot Strait, the shortest route from the southwestern mainland to Newfoundland is fully 70 miles, and, although this does not seem a forbidding gap, the fact remains that very many common Canadian species with fine spores or with the seeds plumose, feathery or otherwise adapted for wind-transportation have failed to cross from Cape Breton to southwestern Newfoundland. Among such plants perfectly adapted, it would seem, for wind-transportation, at least in heavy gales or in winter when advantage can be taken of broad fields of ice, are *Lycopodium sabinaefolium, Adiantum pedatum, Dryopteris marginalis, Pyrola elliptica* and *Chimaphila umbellata,* with very minute spores

Thalictrum dioicum probably *T. confine* which is a characteristic plant about the Gulf of St. Lawrence; his *T. purpurascens* (a species unknown as far east as New England) is undoubtedly the common *T. polygamum* which he does not list; and his *Viola rostrata* (a woodland species very rare east of the Connecticut valley) is more likely *V. labradorica, arenaria,* or *adunca,* all of which occur about the Gulf of St. Lawrence.

or seeds; and *Populus grandidentata, Clematis virginiana, Acer Saccharum, Epilobium molle, Apocynum cannabinum, Asclepias Syriaca, Eupatorium perfoliatum, E. urticaefolium, Solidago squarrosa, S. latifolia, S. juncea, Aster macrophyllus, A. cordifolius, A. acuminatus, Erigeron philadelphicus, Gnaphalium polycephalum* and *Prenanthes altissima* with feathery pappus or other means of buoyancy. And even though the buoyant-seeded plants of Nova Scotia have, since the receding of the Pleistocene ice, failed to reach by means of the winds the opposite side of Cabot Strait, there are plenty of other very common plants of Cape Breton or Nova Scotia proper — such as *Leersia oryzoides, Carex lurida, C. retrorsa, Veratrum viride, Ostrya virginica, Polygonum cilinode, Osmorhiza divaricata* and *Steironema ciliatum,*— the bladdery fruits, light seeds, or dry seed-bearing fragments of which it requires no extreme stretch of the imagination to picture as blowing and bounding on the broad fields of ice finally to find lodgment on the Newfoundland shore. But theoretically simple as this process appears, such conspicuous plants of the Canadian zone seem to have failed utterly in thus crossing Cabot Strait; and if this shortest route to Newfoundland has proved too much for the Nova Scotian species it is quite obvious that the routes from Anticosti (110 miles) and the Gaspé Peninsula (more than 200 miles) are no more efficient. Otherwise we should expect to find upon Newfoundland such very common and conspicuous plants of Anticosti or Gaspé as *Anemone multifida, A. riparia, Clematis verticillaris, Arabis brachycarpa, Dryas Drummondii, Astragalus frigidus,* var. *americanus, Pyrola asarifolia, Erigeron acris,* var. *asteroides, Arnica mollis, A. chionopappa,* and *Prenanthes racemosa.*

Surely, if nearly all the plants (340 + out of 367 + species) which today abound in eastern Canada in the latitudes of Newfoundland (with the exception of the northern peninsula) but which are not characteristic of the sandy coastal country to the southwest, have thus signally failed to reach the island by means of the winds, is it not obvious that such a method for the transportation of *Schizaea pusilla,* for example, from New Jersey to Nova Scotia, thence to Newfoundland, or of the other southwestern plants which compose our Class III, is highly improbable? In fact, from the size and weight of the seeds or fruits of many of these Southwestern Types which are perfectly at home in Newfoundland — for example, *Sparganium diversifolium, Potamogeton Oakesianus, Carex folliculata, Carex in-*

tumescens, Corylus rostrata, Castalia odorata, Pyrus arbutifolia, var. *atropurpurea, Rosa virginiana, Corema Conradii, Ilex verticillata, Viola cucullata, Aralia hispida, Sanicula marilandica, Cicuta bulbifera* (reproduced by bulblets), *Cornus alternifolia, Gaylussacia baccata, G. dumosa*, var. *Bigeloviana, Vaccinium macrocarpon, Convolvulus Sepium*, and *Melampyrum lineare* — it is difficult to see how the winds could have had any efficient part in transporting them from the continent to Newfoundland.

Not only is the flora of Newfoundland composed of boreal and southwestern species with only a very meagre representation of the typical Canadian species but the fauna shows a similar composition. There are several animals, the caribou, marten, Arctic hare, ptarmigan, etc. closely akin at least to Arctic-alpine or Hudsonian species of Labrador, but the moose, porcupine, squirrels, mice, spruce partridge, and many other conspicuous animals of our Canadian forests are unknown; and Mr. Outram Bangs and Dr. Glover M. Allen inform me that the only native mouse of Newfoundland, instead of being one of the common woodland species of eastern Canada, is *Microtus terrae-novae*, the Newfoundland vole, which is closely akin to the Meadow Mice of our New England coast, and that the muskrat of Newfoundland (*Fiber zibethicus obscurus*) is very close to the muskrat (true *Fiber zibethicus*) of our continental swamps and pond shores, a species unknown from Labrador.

As we have already seen, the possibility of the southwestern coastal plants reaching Newfoundland from Nova Scotia by means of birds, ocean-currents, floating logs and ice, or by winds is very slight indeed if not entirely negligible. And surely these agencies would hardly be likely to transport to Newfoundland the vole or the muskrat, neither of which would be apt to undertake long water-journeys. We are therefore ready to consider the possibilities of the flora and at least the southern mammal-fauna of Newfoundland having reached the island by the method which we have not yet discussed, viz. by crossing on a

Post-Glacial Land Bridge. We here approach a problem upon which there is little direct geological or at least paleontological evidence, and many geological friends whom I have consulted are disinclined, from the meagreness of the geological record, to express a final opinion in the matter. But the botanical evidence, at least, is very extensive and of a rather striking nature. The isolation

at northeastern stations of Pine Barren and other Coastal Plain species is by no means confined to Newfoundland. In 1880 Professor N. L. Britton[1] called attention to the fact that many of the plants of the New Jersey Pine Barrens extend northeastward upon the Cretaceous soil (but not on the Drift) of Staten Island, and across Long Island to the similar soils of southern New England; and gradually our knowledge of these northeastern outliers of the flora of the Pine Barrens and even of more southern highly silicious areas of the Coastal Plain has increased until (omitting from consideration all plants which reach Newfoundland) we now know 118 such species which, northeast of Long Island, have remote outlying stations along the coastal strip of New England or the Maritime Provinces, and every season of botanizing is adding one or more species to the list from Prince Edward Island, eastern New Brunswick, Nova Scotia, eastern Massachusetts, Cape Cod, Marthas Vineyard, Nantucket, Rhode Island or southeastern Connecticut. A few examples will make clear this class of cases, 118 species, as already said, besides those which constitute our Class III, Subclass A of the Newfoundland flora. *Sabatia dodecandra* (*S. chloroides*), the splendid rosy pink gentian of coastal pond-shores from North Carolina to eastern Massachusetts, is quite unknown on the continent northeast of Cape Cod or north of Bristol and Plymouth Counties, Massachusetts, but on that remarkable isolated sand ridge and plain, Sable Island, 100 miles out to sea from the southeast coast of Nova Scotia, it is "the chief annual" in the flora.[2] *Aster subulatus* is a characteristic plant of coastal flats from Florida to New Hampshire, is quite unknown on the coast of Maine, southern New Brunswick or Nova Scotia, but reappears (with other southern species) in great profusion on the broad flats at the mouth of the Nepisiguit River as it enters the Baie des Chaleurs in northeastern New Brunswick. *Ilex glabra*, the Inkberry of coastal swamps from Louisiana to Florida and the Atlantic coast as far north as the region of Dorchester Bay, south of Boston, occurs 30 miles away in an isolated area of swamps in Wenham and Magnolia, its most northeasterly station in the United States, but it reappears in sandy swamps of southwestern Nova Scotia. *Magnolia virginica* of our southern Atlantic coast extends northward across New Jersey

[1] N. L. Britton: On the Northward Extension of the N. J. Pine Barren Flora on Long and Staten Islands. Bull. Torr. Bot. Cl. vii. 81–83 (1880).

[2] J. Macoun, Geol. Surv. Can. n. s. xii. 218 A (1902).

to Suffolk County, Long Island, but is unknown east of Long Island except in the famous swamp on Cape Ann (120 miles in a straight line from the nearest Long Island station) where it has been known since the days of Menasseh Cutler. *Betula nigra,* the River or Red Birch so characteristic of swamps and river-banks from Texas to Florida and throughout the lower Mississippi region, extends up our coastal plain to Suffolk County, Long Island, but, save along the lower Merrimac and adjacent regions of southern New Hampshire and northeastern Massachusetts, 115 miles from the Long Island area, is unknown in New England. *Echinodorus tenellus* is found at various stations in the Mississippi valley and about the Gulf of Mexico and the southern coast, but northeast of Canterbury, Delaware, is known only around ponds of Middlesex County, Massachusetts (a gap of 340 miles). *Scirpus Hallii,* originally described from Texas, is abundant on the shores of Winter Pond in Middlesex County, Massachusetts, but, though it is the most distinct and easily recognized species of its subgenus, it is unknown elsewhere in the Atlantic states north of Decatur County, Georgia, and Indian River, Florida, 1115 miles away. These few cases, as said, are typical of this large class of plants, for were the ranges of the remainder of the 118 species very closely scrutinized similar broad gaps in their northern distribution would be quickly apparent — such very local plants in our flora as *Lycopodium alopecuroides, Najas quadalupensis,*[1] *Panicum verrucosum, P. scoparium,*[2] *Leptochloa fascicularis, Eleocharis interstincta,*[3] *E. quadrangulata, E. Torreyana, E. tricostata,*[4] *Scirpus Longii*[5] *Rynchospora Torreyana,*[6] *Scleria reticularis, Carex ptychocarpa, C. subulata, Orontium aquaticum, Juncus brachycarpus,*[7] *J. aristulatus, Saururus cernuus, Rumex hastatulus, Sagina decumbens, Linum floridanum, Ilex opaca, Ascyrum hypericoides, Opuntia vulgaris, Cuscuta arvensis, Stachys ambigua,*[1] *Gerardia parvifolia, Viburnum venosum, Sclerolepis*

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[1] See Bicknell, Bull. Torr. Bot. Cl. xxxv. 60 (1908).

[2] See Hitchcock & Chase, Cont. Nat. Herb. xv. 295 (1910).

[3] See Wiegand, Rhodora, xi. 83 (1909).

[4] See Bicknell, Bull. Torr. Bot. Cl. xxxv. 480 (1908).

[5] See Rhodora, xiii. 6 (1911).

[6] See Rhodora, x. 142 (1908); also Bicknell, Bull. Torr. Bot. Cl. xxxv. 483 (1908).

[7] See C. B. Graves, Rhodora, iv. 27 (1902); and G. G. Kennedy, ibid, 60. Dr. Kennedy's observation that at Scituate, Massachusetts, *Juncus brachycarpus* grew "in a patch of peculiar reddish soil quite different from the general soil of the ridge. The gravel was in small equal sized particles with a peculiar greasy feeling to the hand: and neither the plant nor the soil were observed elsewhere," is peculiarly interesting, since Professor Isaiah Bowman has shown (Science, n. s. xxi. 994) that at Scituate

uniflora,[2] *Eupatorium leucolepis*,[3] *Gnaphalium purpureum*, and *Coreopsis rosea*.

In 1893, Dr. Arthur Hollick, in a significant paper entitled *Plant Distribution as a Factor in the Interpretation of Geological Phenomena, with Special Reference to Long Island and Vicinity*,[4] accounted for the presence on Long Island, Martha's Vineyard, Nantucket and Cape Cod of the Pine Barren plants by demonstrating that after the receding of the Pleistocene ice there existed a land connection along the shoreward margin of the old coastal plain, which now forms the coastal bench extending gradually offshore until at a depth of about 100 fathoms — 600 feet — it abruptly meets the deeper waters of the open Atlantic. Hollick's statements bear so directly on our problem that I quote freely from them: —

"During Cretaceous and Tertiary times a series of fresh water or estuary and marine deposits (clays, sands, gravels and marls) were laid down along the eastern borders of the North American continent. About the close of the Miocene, or the beginning of the Pliocene period, an era of elevation began which finally raised them hundreds, in places thousands of feet, above their present level, forming a vast coastal plain, which extended over the entire area where we now find them, and for a considerable distance eastward, into what is now part of the bed of the Atlantic ocean. On the land side this plain was bounded by the crystalline and Triassic rocks of Connecticut, southern New York, New Jersey, Pennsylvania and southward. . . . The evidences of its extension northward around Rhode Island and Massachusetts are now almost obliterated, but there seems to be every reason to believe that its land limits were approximately the coast line of the present day. . . .Further north than Massachusetts,

are found beds of Pre-Pleistocene deposits, the uppermost being bright red sands. Dr. Kennedy's station for *Juncus brachycarpus* is at "Egypt," where there are some other Coastal Plain plants, Dr. Bowman's outcrop of Pre-Pleistocene red sands and clays at Third Cliff (about four miles south of "Egypt") where it "outcrops for a half-mile along the cliff face." It is desirable to watch at Third Cliff for the *Juncus* and other Coastal Plain species and it may be that remnants of the Coastal Plain occur nearer to Boston than at Third Cliff.

[1] See Wiegand, Rhodora, xi. 83 (1909); and Fernald, Rhodora, xii. 191 (1910).

[2] See F. T. Lewis, Rhodora, vii. 186 (1905); and J. F. Collins, Rhodora, xii. 13 (1910).

[3] *Eupatorium leucolepis* was collected at Kingston, Massachusetts, by W. P. Rich and C. H. Knowlton, August 30, 1908.

[4] Trans. N. Y. Acad. Sci. xii. 189–202 (1893).

so far as I am aware, it is not even indicated, and except for the presence of the well-recognized submerged plateau off our eastern shores all further trace of the former coastal plain is lost. Its eastern limits, where it formerly met the waters of the Atlantic ocean, were probably where we now find the borders of this plateau to be, namely, at the 100 fathom contour."

"Shortly after the advent of the Ice Age the elevation had reached its maximum. The rivers had previously cut deep valleys through the easily eroded material forming the coastal plain, in their courses to the sea, and when the continental glacier, pushing its way southward and eastward, finally flowed over the edges and escarpments of the hard crystalline rocks onto the soft and incoherent material of the coastal plain it scooped it out to a great depth in places, and then, either carrying it forward in mass, or else pushing and squeezing it ahead in a great contorted ridge, capped by the boulder till, finally left it as part of the terminal moraine. . . ."

"Just when the period of elevation ended and that of depression began, in fact, whether it was previous to, or subsequent to that of greatest ice accumulation, is yet a matter of controversy between authorities, but in either case on the retreat of the glacier, we may picture to ourselves the terminal moraine forming an elevated ridge extending through Staten Island, Long Island and the islands to the eastward, forming a continuous, more or less elevated land connection to the north and east, with what remained of the coastal plain sloping away from it on one side and a trough filled with the water from the melting glacier on the other. . . ."

"The present rate of coastal subsidence, as calculated by Prof. Geo. H. Cook, and other authorities, is about two feet per century. At this rate, six thousand years ago practically the whole of the area included within the present twenty-fathom contour would have been above sea level — only the deepest parts of the trough of the Sound being below it. . . . This area, as may readily be seen, includes the whole of Staten Island, Long Island, Block Island, Martha's Vineyard and Nantucket, besides a respectable portion of the submerged coast eastward and southward. It is also probable that at least a part of this area to the eastward, which at the present time is lower than the twenty fathom contour, has become disproportionately so in modern times by tidal scouring, and that it was actually and relatively higher formerly than now."

"Under these circumstances we should, therefore, have had, during a considerable period of time, a continuous strip of land, except for the river outlets, all the way from New Jersey to Massachusetts, separated from the mainland by a body of water occupying the trough scooped out by the glacier, which, in its present depressed and widened condition, we now call Long Island Sound, but which was then a fresh water lake or broad river. Bearing these conditions in mind we next have to consider the still further subsidence of the Champlain Period, the re-elevation of the Terrace Period, and the depression which is again going on at the present day. It is evident that at some time during these oscillations of level the sea, having eaten away the coastal plain, finally reached the barrier of the terminal moraine, where this still remained as the connecting link between Long Island and Massachusetts. The moraine gave way in places, channels were formed and detached portions remained to form the islands which we recognize today as Block Island, Martha's Vineyard, Nantucket and the host of other lesser islands which stream out from the end of Long Island towards Cape Cod and the Rhode Island shore, while the eroded portions are represented by the great submerged ridges which are known as the Nantucket and other shoals." ". . . .it is evident that our theory implies the continued existence of land connection, between New Jersey and southeastern New England, by way of Long Island, during a sufficient period of time after the final recession of the glacier, for the pine barren flora to have spread and become established there. . . . Long Island, Block Island, Martha's Vineyard, Nantucket, etc., as we now know them, have not been submerged since the final retreat of the glacier, and their separation into islands by the submergence of the intervening land is a comparatively modern phenomenon, due to the depression and erosion which are actively at work, and which have produced such conspicuous results during the historic period." [1]

Dana, reviewing in 1894 the botanical evidence, said: "The migration northward of the Pine Barren flora must have been during the latter part of the time of high latitude elevation. . . . . Each stage in the retreat was a contraction of the area of perpetual frost, and a widening of the range of tropical winds, ensuring further encroachment. In view of all the facts, it is probable that before the subsidence had

[1] Hollick, l. c. 196–201 (1893).

made large progress, the ice-sheet had retreated to Canadian territory, excepting the portions left about the higher mountains of eastern and western America."[1]

In 1908, the late John H. Sears,[2] accounting for the presence in Middlesex and Essex Counties of isolated southern plants, cited Dana's discussion of the occurrence in Northumberland Strait and at other points north of Cape Cod of a southern mullosk fauna in which Dana had concluded that, since "none of the shells are found in elevated beaches; ...the migration from south of Cape Cod took place in the Recent period. Such a migration, extending to the St. Lawrence Gulf, was not possible, unless the Labrador current had first been turned aside; and a closing of the Straits of Belle Isle would have brought this about. This implies an elevation of about 200 feet; and it may be that the rise which introduced the Recent period carried the continent, to the north, to this height above the present level. In the Champlain period of subsidence the Straits were open, this being proved by the cold-water shells of the now elevated beaches."[3] And basing his conclusions in part on the presence of the southern plants — *Echonodorus tenellus, Scirpus Hallii, Betula nigra, Magnolia virginiana,* etc., in part on the occurrence in coastal muds of Essex County of southern invertebrates, Sears concluded that the southern flora (and fauna) reached northeastern Massachusetts during the elevation which followed the Champlain subsidence.

Thus, by Hollick's interpretation, which was accepted by Dana (who placed their migration and that of the mullosks of Northumberland Straits at different times) the southern plants reached Cape Cod in "the period of Glacial emergence which made New Jersey, Staten Island, Long Island, with the islands east of it and southern New England, continuous dry land....long before the alleged subsidence had completed its work"[4]; while by Sears the time of the migration of the southern plants is placed after the Champlain subsidence. The final weighing of the more detailed geological evidence must of course be left in other hands, but it is possible that on the more general question we may gain some light by further investigating the origin of the southern flora of Newfoundland.

[1] Dana, Man. Geol. ed. 4, 980 (1894).

[2] J. H. Sears: A Southern Flora and Fauna of Post-Pleistocene Age in Essex County Massachusetts. Rhodora, x. 42–46 (1908).

[3] Dana, l. c. 995.

[4] Dana ,l. c. 995.

In the accounts above quoted of the extension to Massachusetts of the Coastal Plain plants no direct mention is made of one very important item. This is the amount of water which would necessarily have been withdrawn from the ocean in order to form the tremendous masses of ice which, as is now becoming apparent, extended simultaneously over large areas of both the northern and the southern hemispheres. Professor Reginald A. Daly, to whom I am indebted for references to papers on this subject, says: "At the time of their maximum extension the ice-sheets, which have since melted away, covered a total area which may be estimated as from five to eight millions of square miles."[1] And though there is great diversity in the estimates of the average thickness of the ice and consequently of the corresponding decrease in the depth of the ocean with the resultant lowering of sea-level all over the globe, some idea of the magnitude of this change can be gained by the following extracts from students of the subject.

Penck, in 1894, wrote: "The causes of the general rise of sea-level in the latest geological time might perhaps be connected with those climatic changes which the earth underwent in the Glacial period. If, during that time, northern Europe, northern North America, and the Antarctic regions were simultaneously glaciated, a considerable mass of water must have been removed from the ocean, and, if the thickness of ice be assumed as 1,000 meters, the sea-level must have been 150 meters below its present position."[2]

Daly, in 1910, felt that these former estimates were too great and that "the formation of the ice-sheets (which have since disappeared) would produce a negative movement of sea-level in low latitudes to an amount ranging between twenty-five and forty-five fathoms."[3]

Besides the direct removal from the ocean of water sufficient to form the ice, there is a second factor which must be taken into account. This is the gravitative power of the great masses of ice. Using the formulas of R. S. Woodward,[4] Daly calculates that "if the ice had an area of 6,000,000 square miles and an average thickness varying from

[1] Daly: Pleistocene Glaciation and the Coral Reef Problem. Am. Jour. Sci. ser. 4, xxx. 299 (1910).

[2] Penck, Morphologie der Erdoberflaeche, ii. 660 (1894) as translated by Daly, l. c. 298.

[3] Daly, l. c. 300.

[4] Woodward: On the Form and Position of the Sea Level. U. S. Geol. Surv. Bull. 48 (1888).

3,000 to 5,000 feet, the attraction of the ice would lower the level of the equatorial sea by amounts ranging from five to eight fathoms." Consequently, when the front of the northern ice-sheet extended along the coast of New England, the attraction of the ice would tend to some extent to compensate for the negative change of our sea-level produced by direct extraction of water from the ocean; but as the ice-front receded farther and farther to the north the belt of ice-attracted water would shift with it, and when New England, the Maritime Provinces, and Newfoundland were quite free from the ice-sheet and the front of the latter had receded to a point on the Labrador Peninsula, the northward moving rim of heightened water would have passed beyond us and our coast-line would feel little positive effect from this source.

If we now examine a chart showing the contours of the coastal bench which extends as a submerged fringe off the eastern coast of North America and which represents the old land-border of the continent, we shall see that in some places, for instance at Nantucket Shoals and Georges Shoal, the bench comes to within 2 or 3 fathoms of the ocean-surface, while 100 miles off Canso in eastern Nova Scotia, Sable Island rises above the water as a long sand-ridge fully 100 feet high. In many areas — the bench all the way from the coast of the South Atlantic States to Georges Bank, then Brown's Bank, then the coastal banks around western and southern Nova Scotia, Sable Island Bank, the Banquereau, St. Pierre Bank, etc.— there are portions of the old land-border forming an almost continuous chain of submerged plains which, even 100 miles out to sea, show soundings of only 25 to 44, often as low as 10 or 15, fathoms. If we trace the line of soundings which reveals the submerged coastal plain at a depth of 60 fathoms, we shall find that only the very deepest channels, such as the outlet from the deep Gulf of Maine (now 25 miles wide) between Georges Bank and Brown's Bank, or Cabot Strait between Cape Breton and the Banquereau on the west and Newfoundland and St. Pierre Bank on the east, interrupt the continuity of the coastal bench.

Now, if we concede the withdrawal of water from the ocean to form the ice of the Glacial Period and disregard for the moment the possibility of any other change in the level of the coast, it will be obvious that vast areas off our present shore must have their ocean-water withdrawn. If we take Penck's view that "the sea-level must have been 150 meters [492 feet or 82 fathoms] below its present position"

almost the entire coastal bench, cut through only by the deepest channels such as that from the Gulf of Maine and Cabot Strait, would have been dry land. But if Daly's more conservative figures ("between twenty-five and forty-five fathoms") are taken it is apparent that, although much of the coastal bench would have been dry land, there would have been innumerable shallow channels between the uncovered areas.

Furthermore, it is quite apparent that the height of the now submerged coastal bench, composed of friable deposits augmented by great masses of loose terminal moraine material, must, during and after its submergence, have been tremendously reduced not only by the denuding action of the waves but by the strong water-currents aided by the winds. We can gain some conception of this rapid reduction of the height and area of these remnants of the old coastal plain by observations made on Sable Island. In his account of Sable Island, Professor John Macoun said: "When the Admiralty survey of the island was made in 1799 it was found to be thirty-one miles long and two broad, though according to the older French charts it had been forty miles in length and two and one quarter in breadth. Lieut. Burton, who surveyed the island in 1808, found it to be thirty miles long and two wide".[1] In 1855, according to Sir William Dawson, the island was "about 23 miles in length, and from one mile to one and a half in breadth."[2] Des Barre's charts of 1779 show that some of the hills (not the highest he stated) were 146 feet above sea-level. Today the charts show an island less than 22 miles long, and according to Macoun the highest hills "are now but little over 100 feet" in height. Macoun further says in regard to Sable Island: "The popular opinion that as it wastes in one part it makes in another is fallacious. Another erroneous idea is that the wind wastes the hills and levels the land and causes destruction. The wind is a builder and the sea is the leveller. The wind certainly shifts the sand but it cuts out in one place only to build up in another. By it the sand is blown inward, but none to sea, except perhaps to a small extent during a very heavy gale. On the other hand, the currents that are set in motion by the winds, and others of a permanent character, are constantly cutting away the sand and carrying it out to sea, and if

[1] Macoun, Geol. Surv. Can., Ann. Rep. n. s. xii. 213, 214A (1902).
[2] Dawson, Acad. Geol. 380 (1855).

a high tide should throw some of this back, which it often does, the wind, by blowing this inward, at once begins to build up new hills."

It is apparent, then, that during the maximum development of the last ice-advance (the Wisconsin of glacial geologists) a very large portion of our coastal bench must have been above the sea-level of that time, forming, as it were, a broad sand-bar off the mouth of the Gulf of Maine at least to the edge of Georges Bank. Opposite this to the east would have been another continuation of the sandy belt running along the Nova Scotia coast and across Sable Island Bank and the Banquereau to Cabot Strait, with St. Pierre Bank beyond. In fact, since the ice-action was very slight about the Gulf of St. Lawrence and there is no evidence of ice-action on the Magdalen Islands, it is safe to assume that the channel from the Gulf of St. Lawrence (Cabot Strait) was not then of nearly such depth and breadth as at the present time. Then when the ice began to recede and the water from its melting (impeded in its progress seaward by various barriers) began to return to the ocean, the deeper channels would first become filled and not until the ice-front had reached a comparatively high latitude would the more elevated portions of the coastal bench become submerged.

Here, then, would be a strip of sands and similar soils stretching with only slight interruptions from our South Atlantic coast to Newfoundland, and it is probable that not far in the wake of the receding ice and the more boreal plants and animals the Coastal Plain plants with the Newfoundland vole and the muskrat crossed on this sandy bridge to Newfoundland, though some other plants and animals which farther south occur with them or to which they are closely related — *Sabatia dodecandra, Ilex glabra,* etc.— failed to cover the entire distance. Although many of the plants which seem thus to have reached Newfoundland belong to southern or even sub-tropical groups and on the continent find their great development from Cape Cod to Texas or even eastern Mexico, it is apparently unnecessary to assume that at the time of this migration the southeastern edge of the ice was far north of Newfoundland or even had fully receded from the island. For today, with arctic ice often fringing far into the summer the eastern and northern portions of Newfoundland, and snow and ice lying until mid-July or even through the drier summers upon the bleak slopes, *Schizaea pusilla* and *Xyris montana,* isolated representatives of large tropical families, and *Bartonia iodandra,* an essentially endemic

outlier of a southern Coastal Plain genus, fruit profusely among the tussocks of *Scirpus caespitosus* and other Arctic species on the highest alpine barrens of Newfoundland; and *Potamogeton Oakesianus* is there as thoroughly at home with *Sparganium hyperboreum* of Greenland as on Nantucket[1] with *Najas guadalupensis.*

The withdrawal from the ocean of a great body of water to form the Pleistocene glaciers and the gradual restoration of it to cause the submergence of our coastal bench give us, then, a sufficient basis upon which to build the land bridge necessary to carry the Coastal Plain plants, the muskrat and the vole to Newfoundland, and gradually to isolate them upon that island. But other factors may have had to do with the former height of the coastal bench. For instance, in his paper *On Pleistocene Changes of Level in eastern North America,* Baron Gerard de Geer[2] shows that although in the later Pleistocene submergence the ocean covered areas which now are far above sea-level (Mt. Desert Island with late Pleistocene beaches at 210 feet on the hills; St. John, New Brunswick, at about 269 feet; Dalhousie, New Brunswick, at 174 feet; Rivière du Loup at 373 feet; with points farther inland showing beaches at 600–800 feet), southeast and east of this now uplifted region there is a belt including Perth Amboy (New Jersey), Long Island, Martha's Vineyard, southeastern Massachusetts, southern, central and eastern Nova Scotia, eastern Prince Edward Island, the Magdalen Islands, and the southern margin of Newfoundland, which shows no sign of Post-Pleistocene uplift. This line (de Geer's isobase for zero) south of which no evidence has been found of recent elevation is so nearly coincident with the northern line of our supposed land-bridge that the eastern portion of de Geer's map is here reproduced (plate 91, fig. 13), with the omission of the colors and some inland features which do not bear directly on our problem. And, although inland from de Geer's isobase for zero the land has clearly been elevated since Glacial times,[3] Professor J. B. Woodworth, who has kindly helped me to several references, informs me that he knows no evidence of Post-Glacial elevation south of that isobase but that, whatever may be the changes at present going on, there are many evi-

[1] "It [*Potamogeton Oakesianus*] is exceedingly abundant in some of the small ponds of Nantucket, where it fruits very freely." — Morong, Mem. Torr. Bot. Cl. iii. No. 2, 15 (1893).

[2] De Geer, Proc. Bost. Soc. Nat. Hist. xxv. 454–477 (1892).

[3] Recent observations have altered in some details the courses of de Geer's isobases but have not changed his zero line along the coast west of Newfoundland.

dences which demand, since the Glacial Period, a decided subsidence outside that line.

If we now examine the lists of characteristic plants of Class III, the Southwestern plants which, it seems to me, must have crossed from southern New England to Newfoundland on this bridge, we shall see that they are all species typical of our more purely silicious plains, sterile hills, or acid bogs, but not of the better mixed soils such as the glacial till; many of them being plants which in New Jersey are today abundant only on the Cretaceous and Tertiary clays, sands and gravels and which farther south are almost confined to the Coastal Plain and similar areas.[1] If, on the other hand, we examine the list of characteristic Canadian plants which, though abundant on the west side of the Gulf of St. Lawrence, are unknown in Newfoundland, we shall see that they are chiefly species of rich woods, meadows or other well mixed soils, or highly calcareous ledges and gravels.

When, therefore, we consider the fact that the bridge formed by the elevated coastal plain was composed of silicious soils presumably identical with those found upon the southern Coastal Plain of our present continent it is evident that an ideal route was laid out for the spread northeastward of the plants which prosper chiefly in such soils and it is easy to picture the Red Pine, *Pinus resinosa*, accompanied or soon followed by *Schizaea pusilla, Corema Conradii, Hudsonia ericoides*, and the other southwestern plants of highly silicious regions, pushing successfully across the bridge to Newfoundland, while *Sabatia dodecandra* got as far as Sable Island and *Ilex glabra* reached the sandy swamps of Nova Scotia. Here too, in the boggy meadows and about the shallow pools, would be a habitat over which the vole and the musk-rat would rapidly spread. But such a very silicious region would have been highly unattractive to *Adiantum pedatum, Thuja occidentalis, Carex retrorsa, Lilium canadense, Calypso bulbosa, Anemone riparia, Dalibarda repens, Lonicera canadensis, Viburnum alnifolium, Solidago squarrosa, Aster macrophyllus*, and the hundreds of other plants of richer soils, which not only in eastern Canada but farther south (when they occur there) scrupulously avoid the more sterile areas; and even if they did occasionally straggle slightly off the richer soils

[1] Compare, for example, Britton, Bull. Torr. Bot. Cl. vii. 81 (1880) and Cat. Pl. N. J. (1889); Hollick, Trans. N. Y. Acad. Sci. xii. 191, etc. (1893) and Am. Nat. xxxiii. 1–14, 109–116 (1899); R. M. Harper, Rhodora, vii. 69 (1905), viii. 27 (1906).

in which they delight, these plants would have found the long belt of pine barren region of the bridge as forbidding to them then as are such habitats today. Similarly, though the caribou, Arctic hare, ptarmigan and other boreal animals of Newfoundland, would find the bridge congenial territory, the moose, porcupine, and other mammals of the Canadian forest would find little inducement to leave the denser woods to wander far upon the sand-bridge, and for this reason apparently they failed to accompany the vole and the muskrat (as well as the caribou, etc.) to Newfoundland.

To summarize briefly, the indigenous flora of Newfoundland consists primarily of plants which occur to the north, in Labrador, or to the southwest, chiefly along the Atlantic seaboard or the Coastal Plain; the typical Canadian plants, unless their northeastern range extends to the north side of the Straits of Belle Isle, being essentially absent from the island. The distance between Newfoundland and Labrador is not sufficiently great to prevent ready interchange of species across the Straits of Belle Isle, but the distance between Newfoundland and Cape Breton is so great that the plants of the latter region rarely if ever span it. Birds, ocean-currents, drifting logs and ice, and winds prove to be ineffective in carrying to Newfoundland the plants from the southwest, so that an ancient land-bridge is suggested. This is the more demanded from the presence in Newfoundland of a vole and a muskrat, mammals closely related to species of our coastal region. The amount of water withdrawn from the ocean to form the Pleistocene glaciers was apparently sufficient to leave exposed nearly if not all the old coastal plain which now forms the submerged bench off our coast, and in addition there is unquestioned evidence that since the Glacial Period this coastal bench has been much higher than it is now; so that upon this now submerged plain, as the ice-front receded northward, the southwestern plants, most of which still occur on Cape Cod, Long Island or in the Pine Barrens of New Jersey, must have spread to Newfoundland, where now they form an isolated flora.

EUPHORBIA ARUNDELANA, AN ALLY OF EUPHORBIA IPECACUANHAE.

Harley Harris Bartlett.

Dr. Millspaugh has said that "the singular and extremely amorphous" *Euphorbia Ipecacuanhae* "represents in itself seven 'Rafinesquian species,' so greatly does it vary in form, color, inflorescence and leaf." No one who has seen the plant in nature will dispute the statement. The leaves vary from linear to broadly ovate, and between two plants of the same leaf shape, growing in the same square foot of soil, there is often a difference of several hundred percent in the size of the leaves. Some plants are entirely purple, some pale green, in others the purple pigment is definitely localized in certain organs. A colony of *Euphorbia Ipecacuanhae* consists of a host of forms, different enough from one another so that they can be assembled into groups of like individuals. De Vries [1] believes that the species is in a mutable condition.

In the western part of Anne Arundel County, Maryland, there is a close ally of *Euphorbia Ipecacuanhae*, seemingly undescribed, which may be called *Euphorbia arundelana*. Both species grow together in a small area (equidistant from the bridges which cross the Patuxent River to Laurel and Bowie, Prince George's County) designated as "Sassafras fine sandy loam" [2] on the U. S. Soil Survey sheet of Anne Arundel County.

The essential and striking character of *Euphorbia arundelana* is

[1] "Herr Dr. J. W. Harshberger sandte mir Material von *Hibiscus Moscheutos* und *Euphorbia Ipecacuanha* aus Pennsylvania, welches durch den auffallenden Reichthum an Formen auf eine Mutationsperiode für diesen Arten schliessen lässt." De Vries, Die Mutationstheorie, II, p. 664.

[2] This soil type is a brownish or deep yellow sandy loam, heavy at the surface, but lighter in color and texture as the depth increases. "At 26 to 30 inches it passes into a sand or loamy sand varying in color from a light yellow to a reddish brown.... The loose open character of the subsoil allows excessive moisture to pass readily through it, while at the same time the texture of the soil gives it a good water-holding capacity.... The material composing the soil is a marine sediment washed down from the higher lands farther north.... The particles are sharp and angular, indicating that the soil has not been water-worn to a great extent.... The Sassafras fine sandy loam occurs principally in the southern and western parts of the country.... It is found at elevations ranging from 40 to 150 feet above tide." J. C. Britton and C. R. Zappone, Soil Survey of Anne Arundel County, Maryland. (Advance Sheets — Field Operations of the U. S. Bureau of Soils, 1909.)

the presence of broad white appendages, often tinged with pink, on the involucral glands. *E. Ipecacuanhae* has often been described as having exappendiculate glands, but Norton [1] has pointed out that a narrow green appendage is always present. Partly on this ground he excluded the species from the subgenus *Tithymalus*. Dr. Small[2] transferred it to *Tithymalopsis*, and the discovery of *E. arundelana* shows that its affinity is really with the members of this group. In *E. Ipecacuanhae* the appendage is so inconspicuous as to be easily overlooked, in *E. arundelana*, on the other hand, it is quite as conspicuous as in the familiar *E. corollata*. (Compare the text figures.) The range of variation seems to be as great in *E. arundelana* as in *E. Ipecacuanhae*, but the two series of forms present the following contrasting characters. 1) Some forms of *E. arundelana* (not all) are pubescent. In Anne Arundel County there seem to be no pubescent forms of *E. Ipecacuanhae*, nor are there any pubescent specimens of it in the National Herbarium. The presence of pubescence is therefore diagnostic; its absence is not. 2) In the forms of *E. arundelana* the stems are prevailingly of strict, upright habit, whereas those of *E. Ipecacuanhae* tend to be spreading or decumbent. In other characters the two species are strikingly alike. It is especially noteworthy that the finger-thick, deep, vertical roots are indistinguishable.

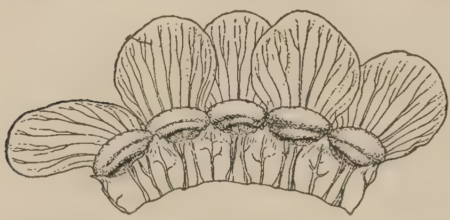

Fig. 1. Euphorbia arundelana. Expanded involucre showing broad appendages. (× 5)

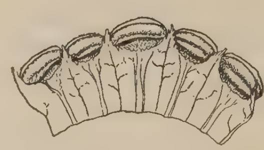

Fig. 2. Euphorbia Ipecacuanhae. Expanded involucre showing very narrow appendages. (× 5)

Euphorbia arundelana sp. nov. Herba perennis habitu *Euphorbiae Ipecacuanhae* simillima. Radix perpendicularis longissima crassitudine circa 1 cm., caulibus subterraneis multiramibus plus minusve tortuosis coronata. Caules plures floriferi annui, altissimi

[1] J. B. S. Norton, Report Mo. Bot. Gard. XI (1900), p. 86.

[2] J. K. Small, Flora Southeastern U. S., p. 1334.

2 dm. attingentes, deorsum alternatim, sursum dichotome vel trichotome ramosi. Folia inferiora squamiformia alterna, superiora verticillata vel saepius opposita, summis exceptis quam internodia multum breviora, amplitudine formaque valde varia, lanceolata vel ovata, mediocria circa 2 cm. longa, sessilia vel brevissime petiolata. Pedunculi erecti in dichotomiis (aut trichotomiis) terminales, quique involucrum unum ferentes, infimi usque ad 7 cm. longi internodia aequantes, summi foliis breviores. Involucrum hemisphaericum glandulis appendice lata patenti conspicua circumdatis.

forma α omnino glabra, foliis caulibusque viridibus; involucri glandulis albo-appendiculatis.

forma β omnino glabra, foliis caulibusque purpureis; involucri glandulis roseo-appendiculatis.

forma γ caulibus, praecipue nodis, foliisque pilosis deinde glabratis, purpureis; pedunculis glabris, involucris extus circulatim ad segmentorum baseis pubescentibus, alibi glabris; glandulis albo-appendiculatis.

In fine sand, southeast of Laurel, Maryland, in Anne Arundel County, 1 May, 1910, Bartlett *1954* (form α), *1955* (f. β), and *1956* (f. γ). The three forms which are defined illustrate the types of variation shown by this species. Other forms are represented by *Bartlett 1952* and *1953*; many more might have been collected.

Since the soil in which *Euphorbia arundelana* grows is agriculturally the best in the region, its native flora is but poorly preserved. The Euphorbias occur in fence corners and in the narrow strips of undisturbed sand between roads and farm fences.

Bureau of Plant Industry, Washington, D. C.

THE MISSOURI RHEXIAS.

B. F. Bush.

The large bright-colored flowers of the Meadow Beauties must be very attractive objects in the sandy swamps of the Eastern and Southeastern States, but in Missouri these plants are so rare that but few collectors have ever seen them growing, and the specimens preserved in the herbarium are very few. Having received from E. J. Palmer some fine specimens of a species of *Rhexia*, collected at Alba, Missouri, in 1909, I was more than commonly interested in determining the species to which these specimens belonged, as I had not seen any plants from so far North as this locality.

I was at first strongly inclined to regard these specimens as belonging to an undescribed species, but after a short study of the plants, I referred them to *Rhexia mariana* L., a species that had been collected several times in Missouri.

However, feeling some doubt as to my disposition of these specimens, I took up the study of the species of *Rhexia* that had been collected in Missouri, and through the kindness of Prof. Trelease was enabled to examine all of the Missouri material of this genus, as well as some specimens from other States, preserved in the Herbarium of the Missouri Botanical Garden.

A careful comparison of this material satisfied me that the plants collected by Mr. Palmer belong to an undescribed species, and a visit to the locality where the plants were collected, on July 24, 1910, further convinced me of their distinctness from any described species.

The locality where this new species of *Rhexia* occurs, is some four miles north of Alba, Missouri, in Jasper County, on a high prairie, about 1100 feet elevation, along little rocky draws that lead to the lower prairie, a place one would be least likely to think of as the habitat of any species of *Rhexia*, a genus which, as is well known, is commonly found in sandy swamps and bottoms.

Synopsis of the Missouri Species of Rhexia.

Stem quadrangular, wing-angled, with slightly concave sides, low, simple or somewhat branched; leaves sessile, narrowly to broadly elliptical, 2–6 cm. long, 10–25 mm. broad, pointed at both ends, broadest at about the

middle, aristulate-tipped, 3-nerved; calyx-tube distinctly and usually rather copiously bristly-hispid . . . . . . 1. *R. latifolia,* n. sp.

Stem cylindric, slender, low, hirsute-pubescent; leaves short-petioled, oblong or linear-oblong, acute at the apex, narrowed at the base, 2–4 cm. long, 4–10 mm. broad, 3-nerved; calyx-tube essentially smooth or with a few scattered bristles . . . . 2. *R. mariana.*

Stem square, stout, tall, slightly pubescent or nearly glabrous; leaves nearly sessile, ovate or ovate-oval, acutish, 2–5 cm. long, 2–4 cm. broad, 3–5-nerved, veiny . . . . 3. *R. virginica.*

1. **Rhexia latifolia** n. sp., erecta simplex vel leviter ramosa 4–6 dm. alta; caule alato-quadrangulari cum pilis rectis patentibus 1–3 mm. longis tecto, faciebus leviter concavis; foliis sessilibus vel subsessilibus anguste vel late ellipticis 2–6 cm. longis 10–25 mm. latis apice basique acutis in media parte latissimis, apice aristatis, supra lutei-viridibus cum pilis rectis sparsis 1–1.5 mm. longis et inter se 1–2 mm. distantibus praecipue inter nervias obsitis, subtus pallidioribus valide 3-nerviis cum pilis praecipue innerviis munitis, margine obscure serrulatis, dentibus minimis; inflorescentia puberula foliosa saepe ramosissima, ramulis gracilibus adscendentibus vel erectis; floribus terminalibus vel in axillis superioribus purpureo-roseis 20–25 mm. diametro breviter (1–2 mm. longe) bracteatis, bracteis lineari-lanceolatis; tubo capsulae globoso ca. 4 mm. longo pilis longiusculis hispido supra in collum subaequilongum vix constricto; dentibus calycis lanceolatis saepissime a fructu deciduis; seminibus stramineis rugosissimis.— Plants 4–6 dm. tall, erect, simple or somewhat branched. Stems quadrangular, wing-angled, with slightly concave sides pubescent with straight spreading hairs 1–3 mm. long. Leaves sessile or nearly so, narrowly to broadly elliptical, 2–6 cm. long, 10–25 mm. broad, pointed at each end, broadest at about the middle, aristulate-tipped, upper surface yellowish-green, with straight scattered hairs 1–1.5 mm. long, and 1–2 mm. apart, mostly between the nerves, the lower surface paler, the hairs mostly along the nerves, strongly 3-nerved, faintly serrulate with long, shallow, ciliate teeth. Inflorescence puberulent, leafy, often much-branched, with slender ascending or erect branchlets. Flowers terminal and in the upper axils, deep purplish-pink, 20–25 mm. broad, on short (1–2 mm. long) pedicels, subtended by linear-lanceolate bracts. Body of capsule globose, about 4 mm. high, with constricted neck of about equal length. Calyx-teeth lanceolate. mostly deciduous from the fruit. Seeds straw-colored, very rugose. High prairies and barrens, Southern Missouri, Arkansas and Oklahoma. Summer and Autumn.

Specimens examined: *Missouri*: Alba, *Bush* 6070, July 24, 1910, type; *Palmer*, July 24, 1910, co-type; *Palmer* 2432, July 7, 1909; Waco, *Palmer*, 923, September 21, 1906; 949, September 21, 1906; 1100, August 11, 1907; 1256, October 4, 1908. *Arkansas*: Hot Springs, *Trelease*, September 3, 1897. *Oklahoma*: Sapulpa, *Paul J. White* 101, August 11, 1900.

2. Rhexia mariana L. Sp. Pl. 346, 1753. A species of sandy swamps, New Jersey to Florida, mostly along the coast, West to Louisiana and Texas, North along the Mississippi river to Southern Missouri, Illinois and Kentucky.

Specimens examined: Missouri: Butler County, *Eggert*, July 27, 1892; Campbell, *Bush* 145, July 20, 1893; Pleasant Grove, *Mackenzie* 322, July 17, 1897; *Bush*, 274, August 13, 1899; Neelyville, *Russell*, July 4, 1899.

3. Rhexia virginica L. Sp. Pl. 346, 1753. A species of low meadows and sandy swamps, ranging from Maine to New Jersey and Florida, mostly near the coast, West to Louisiana, and North along the Mississippi river to Southeastern Missouri and Southern Illinois.

Specimens examined: Missouri: Malden, *Bush* 146, July 22, 1895: Pilot Knob, *Glatfelter*, August 20, 1895.

Courtney, Missouri.

LYCOPODIUM FLABELLIFORME.

W. H. Blanchard.

Lycopodium flabelliforme (Fernald), n. sp. *L. complanatum*, var. *flabelliforme* Fernald, Rhodora, iii. 280 (1901); Gray's Man. ed. 7, 57 (1908). Caule repenti superficiali, ramis 2–3 dm. altis rigidule erectis mense Octobri tertio vel quarto anno fructiferis, hornotinis usque ad 3 cm. attingentibus profunde bipartitis, partibus 5–7-furcatis, lobis dorso planis vel convexis subtus concavis 2–3 mm. latis rarenter secundo anno procrescentibus; foliis minutis adpressis, pedicellis robustis saepe furcatis, pedunculis ca. 7 cm. longis robustis viridibus ab apice erecto lato vel primae vel hinc inde ulterioris furcationis et quam eá uno anno tardius evolutis.

Running stem nearly superficial; upright parts 2–3 dm. high, stiffly erect, maturing fruit in October after third or fourth year; upright stem extension 3 cm. yearly, bearing two branches 5- to 7-forked, flat or convex above, concave below, 2 to 3 mm. broad, branchlets rarely extending the second year; leaves minute, adpressed; strobiles 4 (or rarely 5) $2\frac{1}{2}$ to 4 cm. long, often pointed, on stout, twice forked pedicels; peduncles 7 cm. long, stout, green, from broad erect end of first or sometimes more remote forking of branches, and growing in year following the production of branch.

I propose to show that there is abundant reason for according specific rank to this plant and incidentally to show that it is unique

among our club mosses. It is as distinct from *L. complanatum* L. as is *L. tristachyum* Pursh, and it would do no more violence to a natural classification to make the latter a variety of *L. complanatum* as has been done though perhaps unwittingly as *L. complanatum*, var. *Chamaecyparissus* Milde., than to continue *L. flabelliforme* a variety of *L. complanatum.* The two plants *L. complanatum* and *L. tristachyum* have several distinctive characters in common — they have underground rootstocks, ripen their fruit early in the season, have slender peduncles growing from nearly similar points, and enlarge by growth from the ends of all branches, while *L. flabelliforme* has different or just the opposite characters.

L. complanatum is a skeleton-like, unattractive plant with rootstocks usually well down in the leaf-mould or soil, and the stems arise like distinct plants rather than like those of a trailer. In order to secure a specimen with its rootstock vigorous digging is necessary. One would hardly think of gathering it for decorative purposes. The early maturing strobiles are hardly an inch (2 cm.) long, from one to three in number, more commonly one, borne on a slender peduncle from $1\frac{1}{4}$ to 2 inches (3 to 5 cm.) long. The pedicels are very short, often apparently wanting, and the two strobiles when there are two arise side by side nearly or quite touching. The strobiles are sometimes forked being single at the base and the forking at any place above. The fruiting part appears to be a very insignificant portion of the plant and during the fall season is hardly noticeable, but it remains like that on *L. flabelliforme* though somewhat battered through several years.

L. flabelliforme has a regular, stocky, very attractive appearance; the rootstock is usually almost on the surface of the ground and the plant is used like a vine for decorative purposes and can well be compared with *L. clavatum* L. for such uses, while *L. complanatum* can only be used like *L. obscurum* L. The four (sometimes five) strobiles averaging about an inch (2.5 cm.) long, but varying much and often having a long point, maturing very late in the season, mark very distinctly the outline of a square prism, and are immediately supported by prominent two-forked pedicels borne on a stout, erect peduncle about 3 in. (7 cm.) in length. The fruiting part is thus very prominent.

But *L. flabelliforme* is also distinguished from *L. complanatum* by its method of growth which I think is unique in this genus and is of

especial interest in distinguishing this species from other much-branched ones. According to my observation, in all club mosses except *L. flabelliforme* the ends of all branches and stems are growing points, are tipped with buds. The end of each season's growth is marked by a joint, the position of which in some species *L. annotinum* and *L. clavatum* for examples is very noticeable. In *L. complanatum* the leaves being very minute the axis is practically naked and, marking the end of each season's growth, there is plainly shown a sharp constriction resembling the separation of the thorax and abdomen of a wasp, and each year's growth resembles an elongated sausage.

The growth of *L. flabelliforme* is entirely upward, that is it does not increase laterally. Its growth consists of an annual elongation of the stem of about $1\frac{1}{2}$ inches (3 to 5 cm.) which, a short distance ($\frac{1}{2}$ to 1 cm.) below the top of the terminal bud, sends out two branches which fork and re-fork from five to seven times and result in giving a striking resemblance to a funnel or tunnel with its sides rising at an angle of 30° from a perpendicular, the slant height of the inverted cone being $1\frac{1}{4}$ to 2 inches (3 to 5 cm.). A branch or a part of a branch when flattened has the appearance of a fan, the fact being that it is funnel-form in the field and flabelliforme in the herbarium. Growth from the ends of these branchlets rarely takes place indicating that they are commonly either destitute of buds or that the buds are dormant and the plant grows (except in rare instances) only by a succession of funnel-bearing increases of stems, the funnels completed (except rarely) the first season.

This feature in the structure of this species can be finely shown by comparing *L. tristachyum* or *L. obscurum* with *L. flabelliforme* in the field when the new growth is appearing or is just grown, or by comparing them in the herbarium if secured at this time. If they are exposed to the sun or dry air when secured the new growth soon wilts and the former two will be covered with a wilted fringe, while the latter shows no wilting except the upmost story which will wilt beyond recognition.

L. complanatum makes an annual upward growth according to the same general plan as *L. flabelliforme* which plan however is obscured in the manner of its carrying out. The stem additions are more slender, zigzag, the terminal bud less conspicuous, while the pair of branches are at first very small though unlike *L. flabelliforme* they increase by lateral forking for two or three years.

Not all of the upright parts of these plants ever fructify in either species. Those that do not and which in consequence are often called sterile, continue to increase in the same manner as at first, the fifth year's growth of *L. flabelliforme* being a duplication of the second, etc. The others which by contrast may be called fertile when three or four years old make a change. In *L. flabelliforme* half of the first forking of each branch instead of forking again and again, develops into a broad stem-like segment often one half of an inch high (1.2 cm.) from which the next season the stout peduncle ascends. From this time on the energy of the plant is put into fruiting and the branches, now reduced to one-half of their former breadth, become smaller and smaller in each year's addition, giving the fertile upright parts, or "plants" conical appearance while the sterile ones appear cylindrical. Sometimes the fruiting is from the second or even the third forking but not often. In *L. complanatum* the fruiting is from the second forking generally, but often from the third, and as might be supposed the branch end from which arises the slender peduncle is little or no different in appearance from the others, and the fertile and sterile branches are not noticeably different except, as has been stated already, that the fruiting parts more or less entire always remain, but unlike those of *L. flabelliforme* these are not conspicuous.

Both species are often 12 inches (3 dm.) high "over all." If *L. complanatum* had the stout, erect stem of *L. flabelliforme* it would be much taller. The extreme age any of the upright stems attain is problematical, perhaps ten years. I have had a pretty intimate acquaintance with *L. flabelliforme* for at least ten years, but not till 1909 did I get acquainted with *L. complanatum.* My specimens which I have used in the preparation of this paper and which I collected very carefully and deliberately and in goodly numbers, given in a thin hard woods in Caribou, Maine, in the latitude of Quebec, 46° 50′.

I assume that our American form of *L. complanatum* is the same as the European, but I am not sure. Then again there may be other species sheltered under that name. Two have now been segregated and in my northern searches for *Rubus* I saw some forms of *L. complanatum* which I did not carefully examine but which I suspect were at least not typical.

WESTMINSTER, VERMONT.

A STRIKING COLOR FORM OF VIOLA PEDATA.

A. Louisa Sanders.

In many of the towns of eastern Massachusetts are places locally noted for the profusion of *Viola pedata* to be found there. One such place in Wayland is on Reeve's Hill. About twelve years ago my attention was particularly drawn to the place by the discovery of a single deep colored specimen which was then pronounced dark red. Although the spot has been watched carefully no recurrence of this form has been seen.

While gathering some of the delicately fragrant blossoms of the species there recently, I found two plants whose flowers did not have the usual pale-violet color. Instead, the petals of each were a beautiful pale magenta. This made the specimens so different from the common form that they may be proposed as

Viola pedata L., forma **rosea**, forma nova, habitu var. *lineari-lobae* simillima differt solum petalis omnibus laete roseis.— Sunny southern exposure of a rocky hillside, Wayland, Massachusetts, May 14, 1911.

The plants were about 5 cm. apart, growing in somewhat loose, but not sandy soil, at the edge of a clump of huckleberry bushes. One had four blossoms and the other three, each perfectly formed and of the usual size and shape. Even the white part of the lower grooved petal was not lacking although it was not crossed by the customary dark veins. One of the specimens may be seen at the Gray Herbarium; the other is still living, but unfortunately has formed no fruit.

It was interesting to find on the same day and not ten rods from the above forms, two specimens of the rare white bird-foot, *Viola pedata*, forma *alba* (Thurb.) Britton, and to note that each had fruited. It recalled the pleasure experienced about ten years ago of finding the white ones for three successive seasons in the same locality.

Wayland, Massachusetts.

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